Energy Efficiency as an Investment in Ohio's Economic Future

Skip Laitner, John DeCicco, Neal Elliott, Howard Geller, and Marshall Goldberg

November 1994

American Council for an Energy-Efficient Economy
1001 Connecticut Avenue NW, Suite 801
Washington, DC 20036

Released in Cooperation with the

Campaign for an Energy-Efficient Ohio
400 Dublin Avenue, Suite 120
Columbus, OH 43215

Table of Contents

List of Tables and Figures

TABLES

FIGURES

Preface

The American Council for an Energy-Efficient Economy (ACEEE) is a non-profit research organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. It is based in Washington, DC.

ACEEE recently began a series of state and regional studies to examine the potential employment and macroeconomic benefits of increased investments in energy efficiency technologies. This specific report is being released in cooperation with the Campaign for an Energy Efficient Ohio, an energy efficiency advocacy group based in Columbus, OH. Funding for this study was provided by the Pew Foundation with additional support from the Energy Foundation and the Joyce-Mertz Gilmore Foundation.

Many people worked together to produce this report. Skip Laitner of ACEEE was the overall project leader. He designed the residential and commercial energy efficiency scenarios and completed the macroeconomic analysis. Steve Nadel of ACEEE organized the building and appliance data with support from Robert Mowris, an independent consultant. Neal Elliott and John DeCicco, both of ACEEE, generated the industrial and transportation efficiency scenarios, respectively. Marshall Goldberg, an independent consultant, provided background data on Ohio's energy and economic profile. Howard Geller provided guidance and review.

EXECUTIVE SUMMARY

Energy is the lifeblood of the Ohio economy. It is needed to power office equipment and production machinery, and to transport both people and freight. It provides light, heat and air conditioning for homes, schools and businesses. Energy is also a critical ingredient for a diverse set of consumer goods that range from medicines and children's toys to food and clothing.

But energy that is inefficiently or inappropriately used can constrain the economic activity of a state and thereby limit the job creation process. With abundant opportunities for energy efficiency improvements as well as the development of renewable resources and alternative motor fuels, Ohio is seemingly well-positioned to move from a heavy reliance on coal and nuclear fuels towards a more sustainable energy future.

In 1991 Ohio spent approximately $21 billion to provide heat, light, power and transportation for residents and businesses alike. The annual energy bill is 9.2 percent of Ohio's Gross State Product (GSP) while the United States as a whole spends only 8.2 percent. The total energy expenditure is also 1.8 times greater than the annual tax collection by state government.

Growing uncertainty about the economy and concern about continued environmental degradation are stimulating greater interest in energy efficiency technologies. The interest in energy efficiency grows in spite of dramatic reductions in real energy prices in the past decade. Policy analysts and business leaders are looking at more productive strategies to meet the nation's economic needs, but to do so in a way that enhances environmental benefits. Energy efficiency technologies offer one such opportunity.

This reports examines the energy consumption patterns within the Ohio economy. More specifically, it projects what energy consumption patterns might look like through the year 2010 and then reviews the potential benefits of a scenario that embodies accelerated investment in energy efficiency technologies.

The energy and macroeconomic analysis builds on previous efforts undertaken by the American Council for an Energy-Efficient Economy (and others) in such studies as *America's Energy Choices: Investing in a Strong Economy and a Clean Environment*, and also *Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies*.

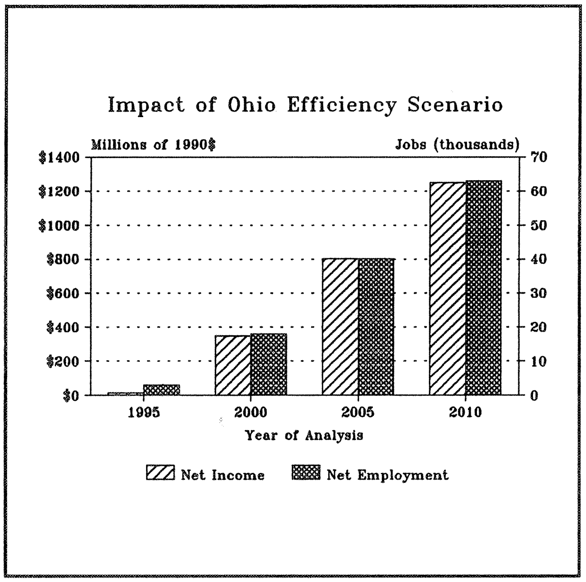
The major findings of the Ohio analysis include:

*** In 1992 Ohio consumed a total of 3,733 trillion Btus of energy for all end-uses, the latest year for which energy consumption data is available for Ohio. That level of consumption represents a per person (or per capita) consumption of 339 million Btus. If we were to think of this energy use in terms of an equivalent amount of gasoline, Ohio's economy requires the equivalent of 2,711 gallons of gasoline to support the livelihood of each resident in the state. This is about five percent greater than for the United States as a whole.

*** The energy efficiency scenario outlined in this study would lower Ohio's energy requirements in 2010 to 10 percent below the 1992 consumption level, and 26 percent below the baseline consumption projected for the year 2010, without reducing services or standards of living.

*** A $28 billion investment in cost-effective energy efficiency technologies between 1995 and 2010 would yield a cumulative energy bill savings of $51 billion over that same period. These values are measured in 1990 dollars. This implies a net positive benefit-cost ratio of 1.82 over the 16-year period of analysis.

*** The investment in energy efficiency technologies would increase the state's employment base — from a modest 300 jobs in 1995 to nearly 63,000 jobs by the year 2010. That rise in employment is equivalent to the number of jobs supported by the output, expansion, or relocation to Ohio of 400 small manufacturing plants.



*** The employment benefits from energy efficiency investments could reduce Ohio's unemployment level in 2010 by about one percentage point — from 5.5 percent to about 4.5 percent, for example.

*** The alternative energy strategy would have a positive environmental benefit for Ohio. Energy-related carbon emissions, for example, would be reduced by at least 22.5 million metric tons in the year 2010, a 26 percent reduction compared to emissions in 2010 in the baseline scenario.

I. Introduction

Energy is the lifeblood of the economic process. It is needed to power office equipment and production machinery, and to transport both people and freight. It provides light, heat and air conditioning for homes, schools and businesses. Energy is also a critical ingredient for a diverse set of consumer goods that range from medicines and children's toys to food and clothing.

Ohio residents and businesses have benefitted from their indigenous coal and oil resources. But energy that is inefficiently or inappropriately used can constrain the economic activity of a state and thereby limit the job creation process.

In 1991, Ohioans spent an estimated $21.1 billion for their total energy use.[1] This annual energy bill represents about 9.2 percent of Ohio's estimated Gross State Product — almost 12 percent more than the U.S. average. Also in 1991, Ohio state government collected a total of $11.6 billion in sales and income taxes.[2] This means that Ohio's energy expenditures were 1.8 times greater than state government tax collections for 1991.

Conventional energy expenditures consume a large share of the state's total economic resources. Moreover, the inefficient use of these energy resources acts as a brake on the economic process, and it contributes to excessive air emissions. Historically, it has also contributed to higher electricity costs due to construction of very costly nuclear power plants and other factors.[3] For those reasons, efforts to accelerate investments in energy efficiency and renewable energy technologies are generating interest throughout the nation.

The importance of maximizing energy efficiency and environmental sustainability together with economic development initiatives is evidenced by the findings of many

---

1. Energy Information Administration, *State Energy Price and Expenditure Report 1991*, U.S. Department of Energy, Washington, DC, September 1993. The 1992 data is not due out until late November 1994, too late for use in this analysis.

2. *U.S. Statistical Abstract 1993*, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1994, Table 483.

3. According to a nationwide study of residential electricity rates, two of Ohio's electric utilities, Cleveland Electric Illuminating and Toledo Edison, have some of the highest rates in the country and made the list of "twenty-five most expensive companies." This information is based on data contained in a press release by the National Association of Regulatory Utility Commissioners (NARUC), April 8, 1994, highlighting some of the results in the *1993 Summer Survey of Residential Electric Utility Bills*. For more information on the recently released report contact NARUC in Washington, DC.

recent studies. Promoting energy efficiency investments not only cuts costs for the user, but yields a positive benefits for the larger economy.[4]

In spite of the economic benefit documented by these recent studies, some states including Ohio have been slow to develop and implement energy efficiency technologies and renewable energy resources. One reason is the significant up-front investment needed in order to reap full advantage of these alternative resources. In short, it takes money to make money.

Unfortunately, alternative energy strategies are also forced to compete against the significantly larger federal tax subsidies given traditional energy resources.[5] Also, in contrast to many other business investments, the benefits of energy efficiency investments tend to be diffuse, accruing to many people over the long-run rather than for a few investors in the short-run.

Policy redirections can go a long way to overcome the momentum of present energy subsidies and provide energy efficiency and renewable energy technologies with the level playing field needed to encourage their market development. These same policies can also help bolster public trust in energy decision making.

The need for new programs and policies in Ohio was confirmed by a three-year public process. In 1991 Governor Voinovich announced in his State of the State message his intent to develop *The Ohio Energy Strategy Foundation Report*. This was published in the spring of 1994.

The *Ohio Energy Strategy* states that "Ohio's citizens and government should develop and utilize energy resources in a manner which fosters economic growth, enhances global competitiveness, employs efficiency and conservation standards, and ensures energy security and environmental quality." The report references a number of broad strategies

---

4. Among others, see, *America's Energy Choices: Investing in a Strong Economy and a Clean Environment*, (Cambridge, MA: The Union of Concerned Scientists, 1991); Howard Geller, John DeCicco and Skip Laitner, *Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies*, (Washington, DC: American Council For An Energy-Efficient Economy, October 1992); Steve Clemmer, *The Economic Impacts of Renewable Energy Use in Wisconsin*, Wisconsin Energy Bureau, Madison, WI, April 1994; and Economic Research Associates, *Energy Investments For A Stronger Louisiana Economy: The Benefits of Accelerated Investments in Energy Efficiency*, prepared for Citizens Fund, Washington, DC, May 1991.

5. See, Douglas N. Koplow, *Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts*, The Alliance to Save Energy, Washington, DC, April 1993. According to this study, federal energy subsidies totaled $39 billion in 1989. Fossil and nuclear resources received 88 percent of this amount, while energy efficiency and renewable energy resources received only 12 percent of the benefit.

and initiatives to accomplish these goals.[6] This study confirms that aggressive implementation of energy efficiency improvements throughout the Ohio economy could yield significant economic and environmental benefits to the state.

Stricter clean air regulations are diminishing the desirability of Ohio's large reserves of high sulfur coal. Yet Ohio's utilities are still heavily dependent on this resource. What once was a major income and employment asset for the state is now a declining resource that contributes to a serious acid rain problem. Nuclear power plants have also proved more costly than anyone originally believed, as evidenced by the high rates being charged by Cleveland Electric Illuminating and Toledo Edison.

Many members of Congress recognize the dilemma posed by the "business as usual" scenario and the need to change energy policies and priorities. The national Energy Policy Act of 1992 included many initiatives to increase energy efficiency in the building and industrial sectors.[7] Initial efforts are now underway to redirect federal funding directly to states to help implement new strategies at the federal, state and local levels.

Federal funding for energy efficiency and renewable energy programs was increased in fiscal year 1995, while funding for nuclear and coal programs was reduced. Also, a resolution with about 130 cosponsors would shift one billion dollars in the overall budget of the U.S. Department of Energy (DOE) away from nuclear and fossil fuels and toward research, commercialization, demonstration and development programs for energy efficiency and renewable energy.[8]

The purpose of this report is to better understand how additional investments in energy efficiency technologies can contribute to lower energy expenditures, new employment opportunities for residents of Ohio, and a generally strengthened economic activity and quality of life. Recognizing that energy consumption and expenditure patterns depend upon the social and economic make-up of a state or region, this report begins with a brief economic profile of Ohio in section II.

Second III provides background information on the state's energy use patterns. It includes information on energy resources, expenditures and electricity consumption.

---

6. See *The Ohio Energy Strategy Foundation Report*, Public Utilities Commission of Ohio, March 1994, page 7; for a brief description of the strategies and initiatives see pages 7-13 of the report.

7. See generally, Energy Policy Act of 1992 (EPAct), Title I, Energy Efficiency.

8. The number of cosponsors are as of October 18, 1994. For more information on House Concurrent Resolution 188, contact Leon Lowery of Representative Sharp's staff at (202) 226-2500.

Section IV is the heart of the report. It outlines an alternative energy efficiency investment scenario for Ohio through the year 2010. It then provides an estimate of the investment needed to achieve both the resulting energy bill savings and the net employment benefits.

Section V summarizes the analytical results. Section VI then identifies some of the past and current initiatives designed to offset increasing energy demand and expenditures. It then offers specific policy recommendations to ensure that Ohio is able to secure the full economic benefits of energy efficiency.

Finally, section VII offers some conclusions and highlights some of the more far-reaching implications of funding for energy and economic investment strategies.

II. Economic Profile of Ohio

A. Population and Income

Ohio's population rose from 10.7 million people in 1970 to 11.0 million people in 1992. This represents a relatively small increase of 3.4 percent in just over 20 years. By comparison, the U.S. population rose by 25 percent in that same period (1970-1992). A smaller population growth might generally be taken as an indication of a smaller level of energy use. As we shall see, this turns out *not* to be the case for a variety of different reasons.

TABLE 1. SELECTED ECONOMIC AND DEMOGRAPHIC DATA

Category	United States	East North Central Region	State of Ohio
Rural Population (1990 percent of total)	24.8%	26.0%	25.9%
Population Density (per square mile)	72.1	175.5	269.0
Persons Per Household (1990)	2.63	2.63	2.59
Per Capita Personal Income (current $)	$19,841	$19,566	$18,624

Source: The information contained in this table in based on calculations from 1992 data (except where noted) found in various tables in the *Statistical Abstract of the United States 1993*. The East North Central region includes Ohio, Indiana, Illinois, Michigan and Wisconsin.

As Table 1 indicates, just under 26 percent of Ohio's population lives in rural areas. This is approximately equal to the regional and the U.S. average. However, Ohio's population density per square mile is almost four times greater than that of the U.S. as a whole and 1.5 times the regional density.

The average number of persons per household is essentially the same for the United States, the region and Ohio. The more densely populated nature of Ohio also suggests that the state may consume less energy for its transportation uses than does the rest of the region and the United States as a whole. Indeed, as we will find later in this report, transportation energy consumption per capita (or per person) is only 80 percent of the nation's.

In 1980, Ohio's per capita income of $9,738 was approximately 98 percent of the average per capita income in the U.S. and just under 97 percent of the regional average. By 1992, per capita income fell to just under 94 percent of the U.S. average and 95 percent of the regional average. This decline occurred despite slow population growth and a record high per capita income of $18,624 in Ohio.

In an overall comparison with other states, Ohio ranked 26th in per capita income in 1992, trailing all the states in its region with the exception of Indiana.[9] The lower income suggests that Ohio may consume less energy per capita than the national average. As it turns out, this is not true. In fact, when all sectors are considered, the state consumes 5.2 percent more energy per capita than the U.S.

B. Employment

In 1992 the Ohio economy supported approximately 5.9 million total jobs.[10] Measured on a per capita basis, the state employment level was 98 percent of the national average, with Ohio businesses providing 0.53 jobs per resident compared with a U.S. figure of 0.54 jobs per resident.

Figure 1 illustrates the employment intensities (i.e., a measure of the number of persons employed) in selected Ohio economic sectors. The figure indexes Ohio's per capita employment in each sector to that of the United States as a whole. Sectors having an employment intensity greater than 100 percent are those which provide more jobs per capita compared to the same sectors within the United States. Similarly, those sectors with an employment intensity less than 100 percent provide fewer jobs per capita compared to those same sectors for the nation as a whole.[11]

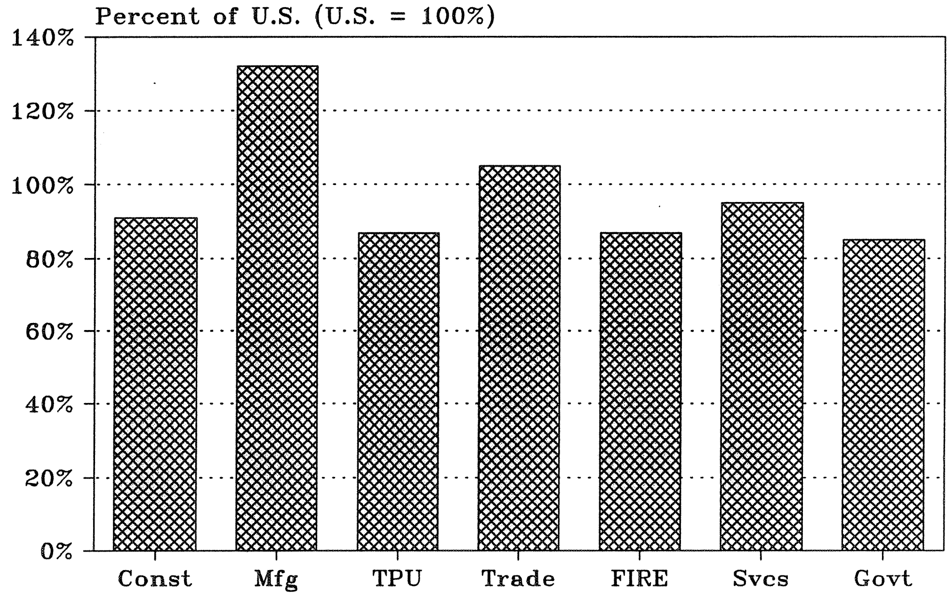
---

9. *U.S. Statistical Abstract 1993*, op. cit.

10. The employment data that follows are provided by the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC, 1993. The data include wage and salaried employees as well as proprietors, self-employed, farm workers, unpaid family workers, private household workers and members of the Armed Forces.

11. The economic sectors noted include: (1) construction (referenced as "Const") - businesses/contractors involved in general building, heavy construction, special trades and other construction activities; (2) businesses involved in wholesale and retail trade ("trade"); (3) manufacturing ("Mfg") - businesses producing nondurable goods such as food products, textile products, chemicals, etc., and durable goods such as lumber and wood products, glass products, machinery, motor vehicles, etc.; (4) finance, insurance, and real estate ("FIRE") - businesses involved in banking, investment services, insurance and real estate; (5) transportation and public utilities ("TPU") - businesses involved in rail, air and bus transportation, trucking and warehousing, pipelines, communications, and electric, gas and sanitary services among others; (6) services ("Svcs") - businesses providing any number of services including: business, auto repair, recreational, household, health, legal, education, etc.; and (7) government ("Govt") - federal, state and local government including civilian and military enterprises. For more details on the specific business or products or services within each of the respective sectors refer to the *Standard Industrial Classification Manual*, Office of Management and Budget, Washington, DC., 1987.

FIGURE 1. OHIO 1992 SECTORAL EMPLOYMENT INTENSITIES



Source: Estimates are calculated from data published by the Bureau of Economic Analysis.

As shown in Figure 1 above, Ohio's manufacturing sector is the backbone of the state's economic base with an employment intensity that is 132 percent of the nation as a whole. Employment in the wholesale and retail trades and services sectors, although not as strong, closely parallels the national labor intensities.

The remainder of the economic sectors reviewed — construction, finance, insurance and real estate businesses (FIRE), and government — all have employment intensities significantly lower, ranging between 85 and 91 percent compared with the United States as a whole. Stated differently, only two of the seven industries noted in Figure 1 have employment intensities equal to, or slightly greater than the U.S. as a whole. However, the number of employees in the more energy-intensive industries is significantly higher than for the U.S. average.

According to the U.S. Department of Energy, just six industries account for 84 percent of total energy use in the manufacturing sector. These include: food processing, chemicals, petroleum refining, pulp and paper, primary metals, and stone, glass and clay products.[12] The Ohio employment intensity in these six industries is more than 146

12. See, "Manufacturing Energy Consumption Survey Preliminary Estimates 1991," *Monthly Energy Review*, Energy Information Administration, U.S. Department of Energy, Washington, DC, September 1993, pages 1-4.

percent of the U.S. average.[13] Normally, this suggests the likelihood of a higher level of industrial use of energy in the state, and this is true of Ohio.

In 1992 Ohio extracted three percent of the nation's coal and was the eleventh largest state coal supplier in the United States.[14] Coal mining represents the roots of many of the state's residents. It defines the social fabric of a large number of communities especially in the Appalachian region. Although eastern and southeastern Ohio historically have produced a considerable amount of high sulfur coal,[15] this abundant resource now provides few jobs in Ohio.

The changing structure of the coal can be seen in the overall drop in employment in the years 1979 to 1990 — prior to the adoption of the clean air act amendments. In 1979 employment in the coal industry was estimated at about 15,500 jobs. By 1990 this had fallen to about 6,300 jobs, a drop of nearly 60 percent.[16] The prospects for future employment in the coal mining industry continue to be bleak.[17] By 1992 coal

---

13. In spite of the significant presence of energy intensive industries, Mike McKee, vice-president and general manager for Ohio Oil Gathering (a crude oil transport company) noted during a personal communication in October 1994 that only approximately 300,000 barrels of oil are refined in the state of Ohio. Most of the crude oil produced in Ohio is transported primarily to major refineries in Pennsylvania and West Virginia. The in-state total of refined oil represents a very small percentage of the 9.2 million barrels of crude oil produced in Ohio. (This annual total for 1992 is based on personal communications with Mike McCormick at the Ohio Division of Oil and Gas, in September 1994). Mr. McKee also noted that the trend in oil well drilling in Ohio is towards deeper more productive wells. Although these new wells are helping sustain existing employment in this end of the industry, over time he believes there will be fewer total wells and fewer employees in the industry.

14. For more detail see the *1992 Report on Ohio Mineral Industries*, State of Ohio, Department of Natural Resources, Division of Geological Survey, Columbus, Ohio, 1993, page 12.

15. In 1992, a total of 84 companies produced an estimated 29.4 million tons of coal from 191 mines. These mines are located in 22 counties all in the eastern and southeastern portion of the state. The total value of coal sales was just under $776 million. Ibid., pages 9 and 12.

16. Coal mining employment includes: production, preparation plant, supervisory, clerical, reclamation and others. This employment information is based on data from *Ohio Coal Development Agenda*, Ohio Department of Development, Ohio Coal Development Office, Columbus, OH, 1992, page 39. During this same period, technological and process advances increased productivity 100 percent—from 25 tons per job-day to nearly 50 tons per job-day. See, *The Ohio Energy Strategy Foundation Report*, op. cit., page 75.

17. For a brief assessment of Ohio's coal future see "Outlook Bleak for Ohio Coal," *The Columbus Dispatch*, Columbus, OH., Sunday, May 15, 1994, as well as the editorial "Handwriting on Wall, Ohio's Coal Industry is on Borrowed Time," Wednesday, May 25, 1994, page 8A, in the same paper.

employment fell to just over 4,600 jobs. These jobs represent less than 0.08 percent of the state's total employment opportunities for that year.[18]

On the other hand, jobs related to increasing energy efficiency are on the rise, even in Ohio. There is increasing the demand for energy auditors and energy service companies (i.e., companies that provide financing and/or installation of energy efficient equipment). Likewise, there are new opportunities and markets for manufacturers of energy-efficient equipment and process controls. For example, Reliance Electric, Inc. based in Cleveland, produces energy-efficient motors and variable speed drives. Whirlpool Corporation produces energy-efficient clotheswashers in Clyde, while General Electric manufactures energy-efficient lamps in Bucyrus and Circleville.

Companies like Sunpower, Inc., a growing energy research and development company in Athens, Ohio, are designing and pursuing commercialization of new energy technologies and expanding their markets. Among their new designs are the free-piston Stirling engine to generate electricity using solar, biomass or other fuel sources, as well as new compressor designs for more energy efficient refrigeration.[19] Combined, these opportunities are expanding and contributing to the state's employment base and economic well-being.

In addition to these direct employment opportunities, and counter to state efforts to shore up the declining coal industry, groups like Rural Action, Inc., a Community Development Corporation, are evaluating Ohio's other equally valuable resources and looking at new strategies and partnerships. Recognizing the limited time span for coal employment, the group is working with local communities on "rural renewal" strategies which include job retraining. Rural Action is working with communities to help retrain today's coal miners to be energy auditors, a growing field of employment which is helping residents, business, utilities and the government save money.[20]

---

18. This information is based on coal industry data from the *1992 Report on Ohio Mineral Industries*, op. cit., page 12, and total employment data from the Bureau of Economic Analysis, op. cit. According to information supplied by Mack Swinford, Geologist with the Ohio Geological Survey, in August 1994, total annual coal industry employment in 1993 declined still further to 4,117 total jobs.

19. This information is based on personal and written communications with Meg Hummon at Sunpower Inc., in Athens, Ohio, in August 1994. See also "EPA Touts Compressor for its Energy Efficiency," *Wall Street Journal*, Friday, June 4, 1993, page B10.

20. This information is based on personal and written communications with Carol Kuhre, director of Rural Action Inc., in August 1994. For more information on this or other programs contact Rural Action in Athens, Ohio.

C. Other Economic Indicators

Comparing data on energy use per dollar of Gross State Product (GSP)[21] offers additional insights about the role of energy as part of the Ohio economy. Table 2 contains relevant data for both the United States and Ohio.

TABLE 2. 1991 ENERGY CONSUMPTION PER DOLLAR OF GSP

	GSP (Billion $)	Energy Expenditures (Billions $)	Energy Expenditures As % of GSP	Energy Consumption (Trillion Btu)	Btus Per Dollar GSP
United States	$5,692	$467.1	8.2%	81,119	14,247
Ohio	$229	$21.1	9.2%	3,686	16,030

Source: The data in this table are adapted from the December 1993 issue of the *Survey of Current Business*, U.S. Department of Commerce, Bureau of Economic Analysis (BEA), and the Energy Information Administration's (EIA) *State Energy Price and Expenditure Report 1991*. The GSP data have been updated from 1990 figures using published information on personal income for 1991.

As Table 2 illustrates, Ohio residents and businesses spent the equivalent of 9.2 percent of the state's GSP on energy.[22] This ratio of energy expenditures to GSP compares to the U.S. ratio of 8.2 percent. As it turns out, the level of energy intensity in Ohio (measured as the number of Btus[23] consumed per dollar of GSP) is also significantly higher—about 12.5 percent greater than the U.S. level. In other words, every dollar of valued-added generated in Ohio requires more energy and a higher level of spending for energy than the U.S. average.

---

21. This refers to the total value of goods and services at market prices produced by the state's economy in a given year. It includes the total purchases of goods and services by private consumers and government, gross private domestic capital investment, and net foreign trade.

22. This includes total expenditures for coal, natural gas, petroleum and electricity in the residential, commercial, industrial and transportation sectors.

23. Btus, or British Thermal Units, refers to the energy or heat value per unit quantity of fuel. One Btu is the quantity of heat needed to raise the temperature of 1 pound of water by 1 degree fahrenheit at or near 39.2 degrees fahrenheit; or roughly equivalent to the amount of heat given off by one wooden kitchen match.

Although the measure of energy used to produce economic output is not a direct indicator of energy efficiency (i.e., industries can be efficient users of energy but still consume large amounts of energy relative to other economic activities), it is interesting to note that the state uses more industrial energy per capita than the United States. It has a disproportionately larger share of industries which are more energy-intensive (as previously referenced). This may indicate a significant base of industries on which to build future energy policy. Ohio accounts for approximately 4.0 percent of the nation's combined GSP and utilizes 4.5 percent of the total energy consumed nationwide.

III. State Energy Use Patterns

A. An Overview

Overall, energy consumption in the state of Ohio has declined approximately 4.3 percent since 1970. When viewed on a per capita basis we see that total energy consumption decreased 7.4 percent during this period, dropping from 366 million Btus (MBtu) in 1970 to 339 MBtu in 1992. In other words, Ohio's total energy consumption decreased at a greater rate than the population increased.

As Table 3 indicates, on the following page, energy consumption in the industrial sector is responsible for the total decline of energy use during 1970-1992, falling 21.1 percent. Much of the change in industrial energy use resulted from the decline of the Ohio steel industry. The impact on the state's total consumption is not surprising when we consider that the industrial sector has consistently accounted for more than 40 percent of Ohio's energy consumption for the years noted.

In spite of this overall decline, Table 3 also reveals that energy consumption in the commercial and transportation sectors has risen substantially. Commercial sector consumption has increased 34 percent while the transportation sector increased 16 percent. Although total and per capita energy consumption has declined significantly during the period noted above, in 1992 Ohio consumed 5.2 percent more energy per capita than did the nation as a whole.

TABLE 3. OHIO ENERGY CONSUMPTION 1970-1992
(IN TRILLION BTU)

Sector	1970	1975	1980	1985	1990	1992	Percent change 1970-92
Residential	829.6	864.3	854.8	780.6	780.4	822.2	-0.9%
Commercial	432.7	453.6	481.0	516.5	557.4	579.1	33.8%
Industrial	1,964.0	1,864.0	1,844.0	1,520.0	1,563.0	1,550.0	-21.1%
Transportation	673.7	762.1	787.3	752.7	796.2	780.3	15.8%
Total	3,900.1	3,944.6	3,967.4	3,570.6	3,697.1	3,732.6	-4.3%
Per capita	366	366	367	333	341	339	-7.4%
Population (000s)	10,657	10,770	10,798	10,735	10,847	11,016	3.37%

Source: The information contained in this table is derived from data in the *State Energy Data Report 1992*, and data from the *Statistical Abstract of the United States 1993*.

As Table 4 on the following page reveals, Ohioans consumed 339 MBtu per person in 1992 compared to the U.S. total of 322 MBtu. If we were to translate this energy into an equivalent amount of gasoline, it turns out that the Ohio requires 2,711 gallons of gasoline equivalent to support the well-being of each resident in the state. Even with the decline noted above, the industrial sector together with the residential and commercial building sectors consumed more energy per capita than the U.S. averages. Only the transportation sector requires less energy than the U.S. per capita consumption.

Taking the major end-use sectors one at a time, the residential sector requires considerably more energy in Ohio at 118 percent of the national average. Although this may appear to be consistent with the rising per capita incomes and the cold winter temperatures, it is surprising given the relatively slow growth in population and the slower rise in personal income compared to the United States as a whole. Moreover, energy expenditures account for one of the largest categories of expenditure in a typical household.[24]

24. According to *The Ohio Energy Strategy Foundation Report*, op. cit. (page 18), energy expenditures in 1990 were the sixth largest expense in a typical Ohio household. This is more than is spent for health care or deposited in various household savings accounts.

TABLE 4. A COMPARISON OF 1992 PER CAPITA ENERGY CONSUMPTION (in million Btus)					
	Residential	**Commercial**	**Industrial**	**Transportation**	**Total**
Ohio	74.6	52.6	140.7	70.8	338.7
United States	63.5	50.5	119.9	88.1	322.0
Ohio as Percent of U.S.	118%	104%	117%	80%	105%

Source: The information in this table is derived from data in the *State Energy Data Report 1992*, and the *Statistical Abstract of the United States 1993*.

Commercial sector energy use is only slightly higher than the national average at 104 percent of the U.S. consumption. The significant number of employees in Ohio's trade sectors (see Figure 1) together with a colder weather pattern than the United States as a whole may account for the higher use of energy in this sector.

Similar to the residential sector noted above, the industrial sector uses 117 percent of the U.S. average energy use. This is consistent with the significant concentration of employees in the manufacturing sectors and the large share of energy-intensive industries noted earlier.

In spite of this greater energy consumption in the residential, commercial and industrial sectors (compared with the U.S. average), the transportation sector lags far behind, at 80 percent of the U.S. average.

B. Energy Expenditures

Viewed on a per capita basis, Ohio spent $1,928 on energy for every person in the state, and used almost 4.7 percent more energy than the United States as a whole. Although average energy prices are equal to the U.S. average,[25] per capita GSP in Ohio is 6.9 percent lower than the national average. The end result is that families and businesses

25. This is an average cost comparison which includes all energy sources in all sectors.

in Ohio spent nearly 12 percent more of the state's GSP for energy than does the average U.S. resident or business.[26]

Table 5 provides a breakdown of Ohio's energy expenditures by fuel type and end-use sector. The expenditures are divided between coal (other than that used by electric utilities), natural gas, petroleum and electricity. The data indicate that Ohio residents and businesses spent just over 80 percent of their total energy expenditures on petroleum and electricity.

The transportation sector was the largest energy user in dollar terms accounting for almost one-third of the state's 1991 total energy expenditures. Following transportation, the residential and industrial sectors each accounted for approximately 25 percent, and the commercial sector accounted for 17 percent.

TABLE 5. 1991 OHIO END-USE EXPENDITURES BY SECTOR AND FUEL (MILLIONS OF CURRENT DOLLARS)

Sector	Coal	Natural Gas	Petroleum	Electricity	Total
Residential	$11.0	$1,698.7	$371.2	$3,340.0	$5,420.9
Commercial	$10.8	$715.9	$123.9	$2,708.7	$3,559.3
Industrial	$336.4	$1,087.4	$1,085.4	$2,776.2	$5,285.4
Transportation	$0.0	$0.0	$6,820.8	$2.3	$6,823.1
Total Expenditures	$358.2	$3,502.0	$8,401.3	$8,827.2	$21,088.7

Source: This information is based on data contained in the Energy Information Administration's *State Energy Price and Expenditure Report 1991*. Based on this EIA reporting format agricultural uses are included in the industrial class together with mining, construction and manufacturing. Government uses are included with the commercial uses, together with trade and service industries.

26. The state's total energy expenditures for 1991 are based on the *State Energy Price and Expenditure Report 1991*, op. cit. The population and income data are taken from the *Statistical Abstract of the United States 1993*, op. cit.

IV. An Energy Efficient Ohio

As cost-effective energy efficiency investments are pursued, economic efficiency is strengthened. A positive off-shoot of such efficiency investments is the strengthening of a state's economic and employment base.

This section of the study offers an insight into what an energy efficient future might look like — both in terms of the needed investment to develop energy efficiency technologies, and in terms of the energy bill savings and employment benefits which might accrue to such investments. The section maps out an alternative high energy efficiency scenario, followed by a review of the analytical tools used to evaluate the macroeconomic benefits of the alternative scenario.

A. The Statewide Energy Efficiency Potential

To better understand the magnitude of economic benefits associated with energy efficiency investments in Ohio it is necessary to construct an alternative energy scenario. From there we can estimate the employment impact within the statewide economy.

As a benchmark for constructing an energy scenario for Ohio we began by establishing a reasonable baseline projection of energy consumptions patterns in the period 1992 through 2010. A variety of Energy Information Administration (EIA) data were used for this purpose. The starting point for the Ohio baseline projection was the actual primary energy use patterns for the building (including both residential and commercial), industrial and transportation sectors in 1992.[27]

With the exception of industrial energy use, the projected change in energy consumption reflected the forecasts contained in the *Annual Energy Outlook 1994*.[28] In that report, total energy use in the residential sector was forecast to grow at a rate of 0.3 percent annually in the period 1992-1994. The annual growth rates for the commercial and transportation sectors were forecast to increase 0.5 and 1.5 percent, respectively.

Because the industrial sector represents a much more diverse grouping of end-users, a different approach was used. As described in more detail below, the result was a projected growth rate of 1.6 percent — slightly higher than the 1.2 percent suggested by

27. See, *State Energy Data Report*, op. cit.

28. Energy Information Administration, *Annual Energy Outlook 1994*, U.S. Department of Energy, Washington, DC, January 1994.

the EIA data. The average annual growth rate among all sectors was, therefore, projected at 1.15 percent.[29]

Using this data we projected that primary energy use would rise from 3,733 TBtu in 1992 to 4,587 TBtu in 2010, a 23 percent increase in total consumption over that period. This trend is illustrated in Figure 2 as the "Baseline Projection."

The alternative energy efficiency scenario, on the other hand, was adapted from the market efficiency scenario developed in *America's Energy Choices: Investing in a Strong Economy and a Clean Environment* (AEC).[30] In that study the authors wanted to examine the role that energy efficiency and renewables might play in meeting the nation's economic needs while reducing pollution, oil imports, and the overall cost of energy. The analytical approach of the 1991 AEC study was improved, updated and applied to the state of Ohio.

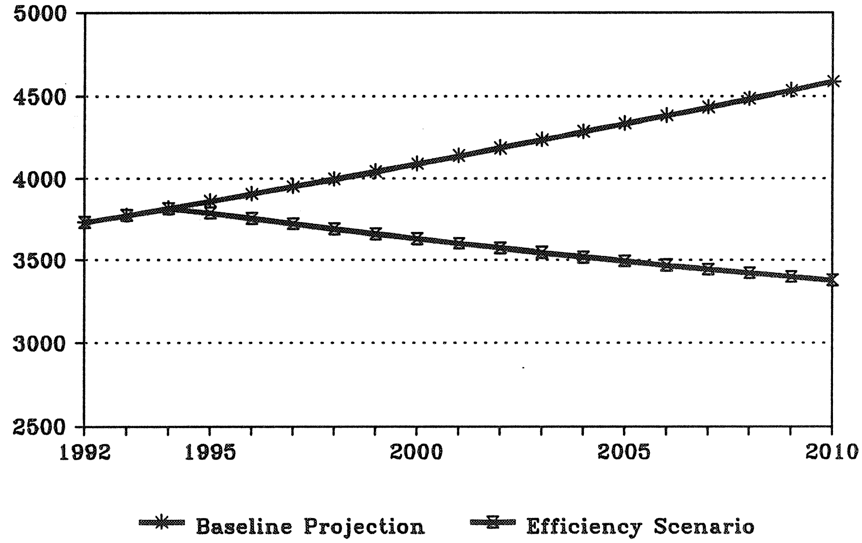
The major assumptions behind the energy efficiency scenario are explained in more detail below. The "Efficiency Scenario" shown in Figure 2 suggests that, using only cost-effective energy efficiency investments, the baseline consumption in the year 2010 might be lowered by 26 percent, from 4,587 to only 3,376 TBtus. This would put Ohio's energy consumption at about 10 percent below its 1992 level.

---

29. Full details of the analytical methods used here will be contained in the technical appendix of the report, *Energy Efficiency as an Investment in the Midwest's Economic Future*, forthcoming in about January 1995. It should be noted that the intent of the analysis was not to "forecast" energy trends, but to "project" reasonable energy use patterns for purposes of evaluating the impact of a high energy efficiency scenario.

30. *America's Energy Choices*, op. cit.

Figure 2. Ohio Energy Scenarios through 2010 (in TBtus)



Source: Calculations by American Council for an Energy-Efficient Economy based upon assumptions described in the text.

Table 6 summarizes both the cumulative investment required for each major end-use sector to achieve the 26 percent energy savings over the 16-year period from 1995 through 2010. It also highlights the cumulative energy bill savings as well as the benefit-cost ratios associated with each end-use sector.

Table 6. Cumulative Efficiency Investments and Savings: 1995-2010 (In Millions of 1990 Dollars)

	Residential	Commercial	Industry	Transportation	Total
Investment	$9,866	$4,4126	$9,908	$4,171	$28,071
Savings	$16,066	$13,345	$13,398	$8,297	$51,106
Benefit-Cost Ratio	1.63	3.23	1.35	1.99	1.82

To build the energy efficiency scenario, the economy was disaggregated into three basic end-use sectors as in the baseline projections. These included: (1) residential and commercial buildings, (2) industrial applications in the agricultural, mining, construction and manufacturing sectors; and (3) automobiles and light-duty trucks within the transportation sector. Analytical models unique to each of the three end-use sectors were used to construct the overall energy efficiency scenario.

The analysis attempted to identify an optimum level of cost-effective energy efficiency improvements that could be obtained by the year 2010.[31] The criterion applied in the analysis was that the amortized cost of a given energy efficiency technology would be less than or equal to the long run cost of conventional energy resources.

Since 1990 is the base-year of the economic analysis, the long run cost is assumed to be the 1990 price paid by each end-use sector for each displaced energy resource. While not a pure measure of long run energy costs, it is a conservative assumption given the anticipated real energy price increases published by the U.S. Department of Energy.[32]

Each efficiency investment is assumed to be amortized over its effective life using a five percent real discount rate. For example, installing more efficient lighting fixtures in an existing office building might reduce electricity consumption annually by about 4.85 kilowatt-hours (kWh) per square foot of occupied space at a cost of $0.50 per square foot. Once the change is made, the equipment can be expected to last 20 years.

At a five percent discount rate, the investment would be amortized at a rate of 8.02 percent annually.[33] Thus, the annualized cost is $0.50 times 0.0802, or $0.0401 per square foot. Saving 4.85 kWh implies a cost of saved energy (CSE) of $0.0401 divided by 4.85, or $0.0083 per kWh. Since the 1990 commercial cost of electricity in Ohio was $0.073 per kWh, this particular measure would clearly be considered cost effective. All technology choices were treated in this manner. A more complete description of the end-use analyses and the assumptions which feed into that analysis follows.

An important caveat should be noted at this point. The intent of the high efficiency scenario is to construct a reasonable profile of investments and energy use impacts,

---

31. Energy savings for those investments made in the period 1995-2010 are not counted in the analysis after 2010. This makes the economic analysis and all benefit-cost ratios very conservative.

32. See, *Annual Energy Outlook 1994*, op. cit., Table A3. In that volume, the average annual increase in real energy prices for the period 1992-2010 are shown to be 0.6 percent for electricity, 1.7 percent for petroleum products and 2.3 percent for natural gas. Rising real costs imply that new resources will cost more than the cost of existing resources.

33. This is based upon the standard amortization formula, $i/(1-(1/(1+i)^n))$, where i is the discount rate and n is the life of the measure.

assuming that cost-effective efficiency measures are widely adopted over the 16-year period of the analysis. Hence, this scenario is not a forecast of what will likely occur given current trends. The high efficiency scenario is, however, a possible future and, as we will show, a desirable energy future for Ohio. After presenting the analysis, we discuss steps that Ohio can take to achieve a high efficiency future.

1. Building Efficiency

ACEEE developed residential and commercial building prototypes using the DOE-2.1E building energy simulation computer program.[34] Commercial building prototypes were developed using data from the Gas Research Institute, Lawrence Berkeley Laboratory, Union Electric Company and PSI Energy.[35] Residential building prototypes were developed using data from a number of sources that are summarized in a study by the American Council for an Energy-Efficient Economy.[36]

Four residential and eight commercial building prototypes were developed in addition to the residential appliance profiles. The residential prototypes include Existing Multifamily Apartment, New Multifamily Apartment, Existing Single Family Detached, and New Single Family Detached. The commercial prototypes include Existing Medium Office, New Medium Office, Existing Medium Retail, New Medium Retail, Existing School, New School, Existing Warehouse and New Warehouse. For those weather sensitive heating and cooling loads, weather patterns for the East North Central Census region were used to adapt the DOE-2.1E model. Residential appliance data were developed specifically for this analysis.[37]

---

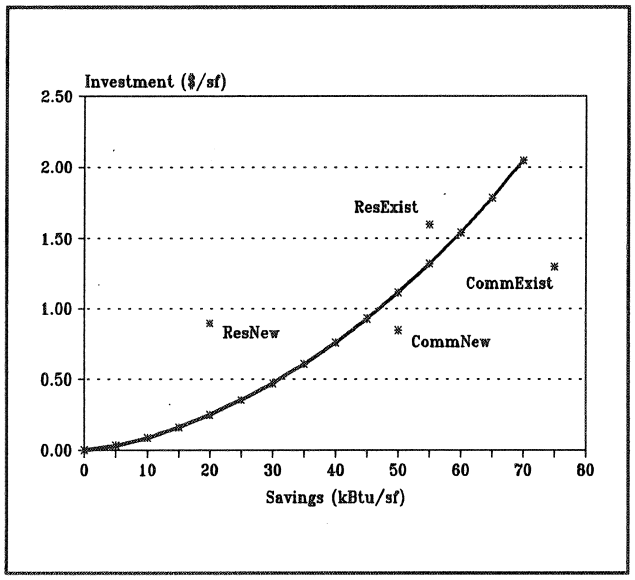
34. Use of the DOE-2.1E model and the data assumptions that underpinned the analysis are documented in a June 1994 unpublished technical memorandum prepared for ACEEE by Robert Mowris, a consulting engineer based in Berkeley, CA.

35. See, *481 Prototypical Commercial Buildings for Twenty Urban Market Areas*, GRI-90/0326, Gas Research Institute, Arlington, VA, April 1991; A. Usibelli, et al., *Commercial-Sector Conservation Technologies*, Lawrence Berkeley Laboratory, Berkeley, CA, 1985; *Existing Commercial Building Prototypes, Union Electric DSM Potential Study*, Union Electric Company, St. Louis, MO, June 1993; and Synergistic Resources Corporation, *New Construction Benchmark Survey*, PSI Energy, Plainfield, IN, December 1992.

36. Loretta Smith and Steve Nadel, *Energy Efficiency Codes and Standards for Illinois*, American Council for an Energy-Efficient Economy, Washington, DC, December 1993.

37. Steve Nadel, unpublished appliance analysis drawing from a variety of contemporary resource data, American Council for an Energy-Efficient Economy, Summer 1994. The appliances include natural gas and electric water heaters, clothes washers and dryers, refrigerators, freezers and lighting.

FIGURE 3. BUILDING COST CURVES



From the data generated by the DOE-2.1E model, four building composites were created and applied in the residential and commercial scenario analysis. The composites were derived from regional estimates of total square footage of the available building types. Figure 3 offers a typical efficiency cost curve for Midwest buildings. It also highlights where each of the building types fall in relation to that average. The vertical axis shows the investment needed per square foot. The horizontal axis shows the level of savings that might be achieved per square foot.

Table 7 summarizes the critical data of the four building composites and the residential appliance profile. From that data we find potential efficiency savings ranges from 32 percent for new residential buildings to as high as 59 percent for existing residential buildings. These are the suggested level of savings found to be economically achievable within the building end-use sector.

The baseline residential projection was designed to reflect an average 0.3 percent annual growth in primary energy consumption in the years 1992 through 2010. Within that growth pattern, we assumed that existing residential units would be lost at the rate of 0.8 percent per year. They would be replaced by new dwellings that met tighter building code standards at the rate of 1.1 percent annually. Appliance energy use would grow at a rate of about 0.4 percent annual. These values generally reflect the reference case data found in *Annual Energy Outlook 1994* previously noted.

The efficiency investments begin in 1995 for the residential high efficiency scenario. Because of the large number of existing residential dwellings, it was assumed that only 80 percent of the cost-effective savings would be achieved by the year 2010. This implies that existing buildings would be retrofitted at a linear rate of five percent annually over the 16-year period 1995 through 2010. More energy-efficient appliances would be adopted at the same rate of five percent annually. For new dwellings, it was assumed that additional savings would be captured in only 90 percent of the units within a 10 year period, ramping up at a linear rate of nine percent per year.

TABLE 7. SUMMARY DATA FOR BUILDING EFFICIENCY ANALYSIS (PER SQUARE FOOT)

Category of Impact	Composite for Residential Buildings			Composite for Commercial Buildings	
	Existing	New	Appliances	Existing	New
Base Usage (kBtu/sf)	89,693	56,164	34,768	199,600	147,800
Cost-Effective Savings (kBtu/sf)	52,903	17,939	12,133	78,400	47,900
Savings as Percent of Baseline	59%	32%	35%	39%	32%
Electric Savings (%)	7%	14%	70%	89%	97%
Natural Gas Savings (%)	93%	86%	30%	11%	3%
Average Energy Price ($/MBtu)	$5.26	$5.40	$6.62	$6.33	$6.50
Efficiency Investment ($/sf)	$1.598	$0.897	$0.255	$1.289	$0.847
First Year Savings ($/sf)	$0.279	$0.096	$0.080	$0.501	$0.315
Simple Payback (years)	5.7	9.3	3.2	2.6	2.7
Cost of Saved Energy ($/MBtu)	$2.42	$4.02	$1.69	$1.32	$1.42

Notes: All energy values and prices reflect primary rather than end-use perspectives. Electricity was converted using the assumption of a 31 percent delivered efficiency, or 11,063 Btus per kilowatt-hour (kWh) of end-use consumption. The energy costs reflect weighted primary energy costs. These vary according to the fuel mix assumed in each building prototype. The "kBtu/sf" unit of measure refers to a value of 1,000 Btus per square foot. Simple payback is derived by dividing the efficiency investment by the anticipated first-year savings. The cost of saved energy reflects the annualized cost of the efficiency investment (in dollars per million Btus) as amortized over the life of the investment, using a five percent real discount rate.

The result of these assumptions is that by the year 2010, residential energy consumption would be 39.4 percent lower compared to baseline projections. As shown in Table 6, the high efficiency scenario requires a $9.9 billion efficiency investment over the period 1995 through 2010. Cumulative energy bill savings (based upon 1990 energy prices) would be $16.1 billion.[38] Hence, the benefit-cost ratio for a residential building scenario is 1.63. This ratio is a conservative estimate since energy savings will continue after 2010.

The baseline commercial scenario was designed to reflect an average 0.5 percent annual growth in primary energy consumption in the years 1992 through 2010. The commercial efficiency investments also begin in 1995. Existing commercial buildings would be lost at the rate of 1.3 percent per year while new units would be built at the rate of 1.8 percent annually. Again, these values generally reflect the reference case data found in the *Annual Energy Outlook 1994*.

In the case of commercial primary energy savings we assumed that 100 percent of the full economic energy efficiency improvements would be captured over the 16-year period. This implies that efficiency improvements in existing commercial buildings will increase linearly at a rate of 6.25 percent annually. For new buildings, it was assumed that 90 percent of the economic savings would be captured within a 10 year period, ramping up at a linear rate of nine percent per year.

The result of these assumptions is that by the year 2010, commercial energy consumption would be 39.2 percent lower compared to baseline projections. As shown in Table 6, the high efficiency scenario requires a $4.1 billion efficiency investment in energy efficiency measures over the period 1995 through 2010. Cumulative energy bill savings (also based upon 1990 energy prices) would be $13.3 billion. Here, the benefit-cost ratio is 3.23, even without accounting for energy savings after 2010. The higher benefit-cost ratio is an indication of the significant energy savings that can be captured in commercial buildings.

2. *Industrial Efficiency*

The industrial sector represents a diverse grouping of entities including: farming, agricultural services, forestry, fisheries, mining, construction and manufacturing. Because of this diversity, and the fact that energy use is an integral part of many of the

---

38. The macroeconomic analysis of the high efficiency scenario is based upon a 1990 Ohio input-output economic model. To simplify the analysis, 1990 energy prices were used in determining energy bill savings. Since real prices are expected to increase (see note 32, supra), this tends to understate savings in the economy.

operations performed in this sector, a different approach was required from that used for buildings.

As part of this effort, ACEEE has developed a methodology for the estimation of base case energy consumption in the industrial sector and the potential for cost-effective energy-efficiency improvements. This analysis requires three steps: (1) project a consumption baseline for the industry groups in Ohio; (2) estimate the economically viable savings potential from efficiency measures for each industry group; and (3) estimate the investment necessary to achieve and maintain that savings.

Information on energy consumption at the state level within the industrial sector has been difficult to obtain and is of varying quality. Energy end-use varies widely among the different industry groups, and even among industries within some of those groups, so the energy efficiency opportunities also vary.[39]

Among the states, the distribution of industries vary widely. As a result of these two factors, it is important to have a representative disaggregation of energy use within the industrial sector for a state in order to make meaningful estimates of the potential for energy efficiency improvements and identify areas of greatest opportunity for energy savings.

This study uses state employment data to apportion *State Energy Data Report*[40] estimates of industrial energy consumption at the state level to eleven industrial groupings.

Annual Energy Outlook 1994[41] projections for energy growth for industrial groups at the national level are combined with Bureau of Economic Analysis[42] estimates of employment growth at the national and state levels to develop estimates of energy consumption growth for each industry grouping at the state level. These data are then used to project a baseline energy consumption for the industry sector to the year 2010.

---

39. R. Neal Elliott, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, American Council for an Energy-Efficient Economy, Washington, DC, 1994; M.H. Ross, P. Thimmapuram, R.E. Fisher and W. Maciorowski, *Long Term Industrial Energy Forecasting (LIEF) Model (18 Sector Model)*, Argonne National Laboratory, Argonne, IL, 1993.

40. *State Energy Data Report 1992*, op. cit.

41. *Annual Energy Outlook 1994*, op. cit.

42. Bureau of Economic Analysis, *Regional Employment Database*, U.S. Department of Commerce, Washington, DC, 1994.

Estimates of consumption are made for both electricity and all other fuels combined. Explicit estimates of natural gas consumption are not made because most non-electric efficiency measures are not fuel specific and sufficient data are not available to account for non-electric fuel switching within industry groups.

An indirect estimate of natural gas consumption is made by multiplying the 1991 national natural gas fraction of non-electric fuel consumption by the non-electric fuel consumption estimate for the industry group. This estimate does not account for differences at the state level or changes in fuel mix over time.

The energy conservation potential was estimated using conservation supply curves derived from the Long-Term Industrial Forecast (LIEF) model.[43] Most conservation supply curves have been developed by combining various characteristic measures for a particular market. Such an approach is impractical for the industrial sector because of the complexity and sight-specific nature of many measures.

The LIEF curves were developed from a historical analysis from 1958-1985 of sectoral energy intensities and prices. The model segregates industries into 18 categories that have similar energy use characteristics based on their historical energy use data, and treats electricity and all other fuels use separately.

Table 8 presents the average fuel prices for 11 industry groupings and the efficiency potential by industry at different fuel prices. The savings potential is measured as the percent reduction from the baseline consumption estimate of a given industry.

The potential efficiency values in Table 8 are developed specifically for Ohio. The maximum economic savings potential was assumed to be the point on the curve at which the marginal cost of energy saved equalled the current fuel or electricity price. In the case of electricity, the average 1990 price of industrial electricity ($0.040/kWh) was used.[44] For other fuels, the estimated average price based on fuel mix for that particular industry group was used. The efficiency curves reflect the different savings potential based upon price and industry.

---

43. Ross, et al., op. cit.

44. *State Energy Price and Expenditure Report 1992*, op. cit.

Table 8. Cost-Effective Savings Potential Based On Energy Price

Industry	Average 1990 Price		Electricity Savings ($/kWh)			Fuel Savings ($/MBtu)		
	Electricity	Fuel	$0.02	$0.04	$0.06	$2.00	$4.00	$6.00
Agriculture	$0.04	$6.64	10%	40%	53%	20%	43%	54%
Mining	$0.04	$4.05	10%	40%	53%	20%	47%	59%
Construction	$0.04	$4.71	10%	40%	53%	20%	43%	54%
Food	$0.04	$3.15	21%	48%	59%	0%	0%	0%
Pulp & Paper	$0.04	$1.34	11%	25%	32%	15%	26%	32%
Chemicals	$0.04	$2.73	11%	25%	32%	15%	26%	32%
Petroleum Refining	$0.04	$1.46	11%	25%	32%	20%	43%	54%
Rubber and Plastics	$0.04	$3.70	14%	57%	71%	20%	47%	59%
Primary Metals	$0.04	$2.15	4%	22%	31%	10%	22%	28%
Metal Fabrication	$0.04	$3.59	14%	57%	71%	20%	47%	59%
Other Manufacturing	$0.04	$2.82	21%	48%	59%	20%	39%	48%

Notes: This table shows the energy savings potential in percent based upon the price of energy paid by the respective industry. The electricity prices are shown as dollars per kilowatt-hour ($/kWh) while fuel prices are dollars per million Btus ($/MBtu). The savings refer to the percent reduction from baseline consumption estimates. The estimates shown here are taken from the Long-Term Industrial Forecast (LIEF) model described in the text.

As an example, if an Ohio food processing plant pays $0.04 per kilowatt-hour (kWh) for electricity, the efficiency potential is 48 percent of current consumption. For a primary metals manufacturing plant, the savings potential is only be 22 percent. The difference is a function of both the way each industry typically uses energy and the steps already undertaken by that industry to save energy.

The investment needed to achieved a particular level of energy savings is based on the assumptions of an average ten year technology life and a five percent real discount rate. In reality, the life of the measures will vary depending upon the measure and the point in the economic cycle of the specific plant at which the measure is applied. Ten years is the median life for many of the industrial measures and is used as a simplifying assumption.

Efficiency investments in the high efficiency scenario are estimated by multiplying the estimated energy savings in each year by the average capital cost. The investment is calculated for each industry grouping since the average fuel price varies by industry due to differences in fuel mix. Because the average measure life is assumed to be 10 years, the capital expenditures made in the first years must be repeated beginning in 2005 in order to maintain the savings realized in those prior years.

It is assumed that 100 percent of the maximum savings shown in Table 8 is achievable by the year 2010. But it is assumed that energy efficiency measures are implemented gradually. In particular, the annual savings, beginning in 1995, was estimated as one-sixteenth of the maximum potential. In this manner, a high efficiency scenario was generated for the industrial sector.

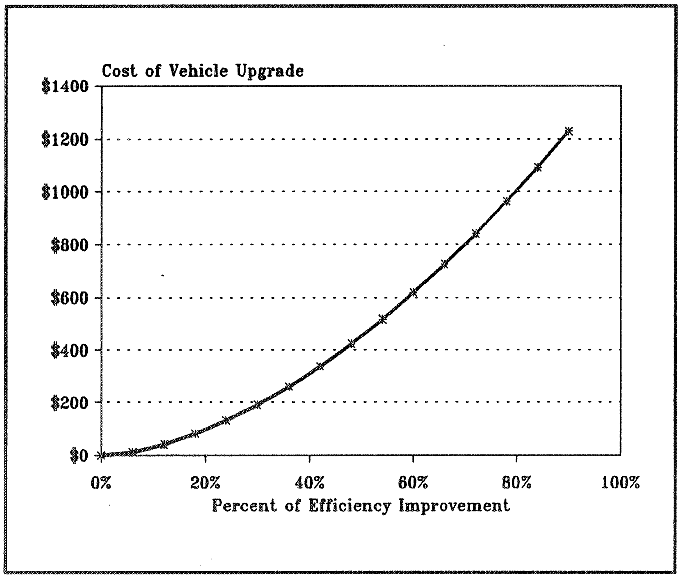
The result of these assumptions is that by the year 2010, consumption is reduced by 18 percent compared to the base case projection. The potential for conserving industrial fuels is relatively modest. This is, in large part, because average fuel prices are low in key industries such as steel, paper, chemicals, and petroleum refining. With electricity, the total consumption actually decreases over time in the high efficiency scenario, resulting in a 2010 consumption that is 28 percent less than the base case. The net result for all primary energy consumption in the industrial sector is that primary energy consumption would be 23 percent lower compared to baseline projections.

The high efficiency scenario requires a $9.9 billion investment in greater energy efficiency over the period 1995 through 2010 (in constant 1990 dollars). Cumulative bill savings (based upon 1990 energy prices) would be $ 13.4 billion. Hence, the benefit-cost ratio for the industrial sector scenario is 1.35.

3. *Transportation Efficiency*

In the transportation sector, only light duty vehicle fuel efficiency improvements are estimated as part of the overall high efficiency scenario. In other words, truck, air and water travel were ignored as were any effects from reduced travel demand (i.e., increased use of mass transit or carpooling). Thus, only about 60 percent of the transportation fuel consumption is directly addressed in this analysis.

FIGURE 4. VEHICLE EFFICIENCY COST CURVE



An engineering-economic analysis was performed in 1993 by DeCicco and Ross to estimate the costs of improving new light duty vehicle fuel economy under varying assumptions about the availability of technology.[45] For the purposes of this study, ACEEE adopted the mid-range (Level 2) estimates of the 1993 report for the 1995-2005 time period. These are given as a cost curve in Figure 4. The efficiency improvement potential for 2010 is based on the higher-range (Level 3) estimates, using a similar methodology.

The curve in Figure 4 represents the average new vehicle price increment (referenced in 1990 dollars) needed to achieve a given percentage increase in new vehicle fuel economy over the base year level. To facilitate comparisons at various fuel prices, the empirically derived cost-benefit estimates were fit to a power function. The following relationship represents the DeCicco and Ross Level 2 cost curve:

$$COST = \$1468*PCT^{1.6937}$$

where COST is average new vehicle price increment (in 1990 dollars) and PCT is percentage fuel economy increase over the base year level.[46] Economic measures such

45. John M. DeCicco and Marc Ross, *An Updated Assessment of the Near-Term Potential for Improving Automotive Fuel Economy*, American Council for an Energy-Efficient Economy, Washington, DC, November 1993.

46. The fit is quite good for this cost curve since the R-squared value is 0.997.

as cost of saved energy (CSE) were derived from this relation using standard formulas and appropriate assumptions regarding vehicle usage, lifetime, and discount rate.

Technology improvements for raising new car and light truck fuel economy are assumed to be phased in over a roughly 10-year time horizon (by 2005). For example, this scenario would have average new car fuel economy reaching 36 miles per gallon by 2000 and 45 miles per gallon by 2005.

The appropriate gasoline price against which to compare the costs of fuel economy improvement is a levelized retail fuel price over the ownership period of the vehicles. For example, the projected national average gasoline price in 2010 is $1.37/gallon (in 1990 dollars, including state and federal taxes). This price provides a reasonable estimate of the average avoided fuel cost over the life of new vehicles sold in 2005.

The cost of saved energy for automotive technology improvements is computed using a five percent real discount rate and a 12-year vehicle lifetime. Using these life-cycle costing assumptions yields the estimate that 65 percent improvement in fuel economy would be cost-effective for new vehicles in 2005.

Market-wide costs of fuel economy improvement are estimated at the new car and light truck retail level. While initial investments are made by the auto industry and their suppliers, the costs of technology improvement are assumed to be fully passed on to car buyers. We assume a linear increase in new fleet fuel economy starting in 1996; we use a rate of six percent improvement per year, so that by 2005 the new vehicle fleet has an efficiency 60 percent higher than that in the base year (slightly below the estimated cost-effective potential of 65 percent).

Ongoing advances in automotive engineering are expected to make yet further efficiency improvements available in the post-2005 time frame. As noted above, we assume that further progress is captured by the DeCicco and Ross Level 3 estimates, which estimate the technical feasibility of a 90 percent improvement (over the 1990 new fleet average fuel economy). Therefore, we assume that annual six percent increases in fuel economy continue through 2010, by when a 90 percent improvement would be achieved. This implies a new car fuel economy of 53 miles per gallon in 2010.

To estimate the energy savings from higher fuel economy, one must account for the vehicle stock (all cars and trucks, new and used, in service in a given year) and its turnover. A stock retirement model was constructed using vehicle usage and scrappage statistics.[47] This model first estimates the EPA-rated fuel economy of all cars and light

47. See, S.C. Davis and S.G. Strang, *Transportation Energy Data Book: Edition 13*, Report ORNL-6743, Oak Ridge National Laboratory, March 1993.

trucks on the road by weighting vehicles of a given age according to their probability of survival to that age and the average number of annual miles driven by age. Further details on this technique are described by DeCicco.[48]

Because on-road fuel economy is lower than EPA-rated fuel economy, a 20 percent downward adjustment is made to account for the shortfall, based on the estimates of Mintz et al.[49] Finally, adjustments are made to account for the takeback (rebound) effect of greater driving because higher fuel economy lowers the cost per mile. Takeback was computed using an elasticity of travel with respect to fuel cost of -0.10 based.[50] The result is a series of estimates of the projected real-world average fuel economy of all cars and light trucks on the road (new and used) in each future year, corresponding to the progress in new vehicle fuel economy described above.

Based upon the economic assumptions found in the *Annual Energy Outlook 1994*, total transportation energy use was projected to rise by about 1.5 percent annually in the baseline scenario. Adapting the light-duty vehicle efficiency assumptions described above, consumption will rise by only 0.70 percent annually. Unlike the buildings sectors, for example, this is still a positive growth rate since efficiency improvements are only made in vehicles that account for about 60 percent of total transportation energy. Again referencing date in Table 6, the cumulative investment required by consumers for increasing vehicle efficiency is estimated at $4.17 billion while the cumulative savings are pegged at $8.30 billion (in 1990 dollars). Thus, the benefit-cost ratio is 1.99.

B. Economic Impact Analysis

With both the baseline projection and the efficiency scenario established, the question posed by the analysis is: "What are the employment and other macroeconomic benefits for Ohio if the state's baseline energy use were reduced by 26 percent, or about 1,210 TBtu by the year 2010?"

In effect, we are examining the benefits of lowering energy consumption from a projected annual growth rate of about 1.2 percent to an annual decline in the state's energy

---

48. See John M. DeCicco, "Projected fuel savings and emissions reductions from light vehicle fuel economy standards," *Transportation Research* 29A(1), forthcoming, 1994.

49. M.M. Mintz, A.R.D. Vyas, and L.A. Conley, "Differences between EPA-test and in-use fuel economy: are the correction factors correct?", Paper No. 931104, Transportation Research Board, Washington, DC, January 1993.

50. D.L. Greene, "Vehicle use and fuel economy: How big is the 'rebound' effect?", *Energy Journal* 13(1), January 1992.

requirements of about 0.6 percent. One tool that can assist in that type of evaluation is referred to as input-output modeling, sometimes called multiplier analysis.

Input-output models initially were developed to trace supply linkages in the economy. For example, they show how purchases of lighting equipment not only benefit lighting manufacturers, but also the fabricated metal industries and other businesses supplying inputs to those manufacturers.

The employment that is ultimately generated by expenditures for energy efficiency will depend on the structure of a local economy. States which produce fabricated metal products, for instance, will likely benefit from expanded sales of locally manufactured ballasts; states without such production will not benefit in the same way.

Different expenditures support a different level of total employment. Table 9 compares the total number of jobs in Ohio directly and indirectly supported for each one million dollars of expenditures within key sectors such as agriculture, construction, manufacturing, utility services, wholesale and retail trade, services, and government.[51] For the purposes of this study, a job is defined as sufficient work to employ one person full-time for one year.

Of immediate interest in Table 9 is the relatively small number of jobs per million dollars supported by expenditures for gas and electric utility services. As it turns out, much of the gain in job creation from energy efficiency programs is derived by the difference between jobs within the utility supply sectors and jobs which are supported by the respending of energy bill savings in other sectors of the economy.

---

51. In this study we have adapted the 1990 IMPLAN model for the analysis. See, for example, *Micro IMPLAN User's Guide*, Minnesota IMPLAN Group, Stillwater, MN, January 1993. Table 9 presents what are referred to as Type I multipliers, incorporating only the direct and indirect effects of an expenditure. Adding the induced effect — i.e., the additional level of impact made possible by the respending of wages in the Ohio economy — would generate what are known as the Type II multipliers (or Type III multipliers as referenced in the IMPLAN model). However, since household spending is part of the final demand changes it was decided to limit the employment and other macroeconomic impacts to the Type I multipliers. This will tend to understate the net effect of the efficiency scenario. For more information on this point, see, Ronald E. Miller and Peter D. Blair, *Input-Output Analysis: Foundations and Extensions*, Prentice-Hall, Inc., Englewood, NJ, 1985, pages 25-30.

TABLE 9. OHIO EMPLOYMENT MULTIPLIERS FOR SELECTED ECONOMIC SECTORS

Sector	Employment Multipliers
Agriculture	22.7
Coal Mining	11.2
Oil/Gas Mining	6.3
Construction	18.2
Food Processing	10.1
Pulp and Paper Mills	9.0
Oil Refining	0.8
Stone, Glass, Clay	11.9
Primary Metals	8.8
Metal Durables	11.9
Motor Vehicles	7.4
Other Manufacturing	10.2
Electric Utilities	6.9
Natural Gas Utilities	2.3
Wholesale Trade	19.6
Retail Trade	42.2
Finance	21.3
Insurance/Real Estate	9.0
Services	27.7
Education	46.1
Government	27.9

Source: Adapted from IMPLAN database for the State of Ohio. The employment multipliers represent the direct and indirect jobs supported by a one million expenditure for goods or services purchased from a given sector.

C. An Illustration: Jobs From Government Efficiency Improvements

To illustrate how a job impact analysis might be done, we will use the simplified example of a state agency that installs $1.0 million of efficiency improvements. Government agencies, traditionally large users of energy due to heating and air conditioning loads, significant use of electronic office equipment and the large numbers of persons employed and served, provide substantial opportunities for energy saving investments. The results of this example are summarized in Table 10, on the following page.

The assumption used in this example is that the investment has a positive benefit-cost ratio of 2.00. This is a comparable ratio as those shown in Table 6. If we anticipate that the efficiency changes will have an expected life of 15 years or more, then we can establish a 15-year period of analysis. We further assume that the efficiency upgrades take place in the first year of the analysis, while the energy savings occur in years one through 15.

The analysis also assumes that we are interested in the *net effect* of employment and other economic changes. This means we must first examine all changes in business or consumer expenditures—both positive and negative—that result from a movement toward energy efficiency. Then each change in expenditures must be multiplied by the appropriate multiplier (taken from Table 9) for each sector affected by the change in expenditures. The sum of these products will then yield the net result for which we are looking.

In our example there are four separate changes in expenditures, each with their separate multiplier effect. As Table 10 indicates, the net impact of the scenario suggests a gain of 32.3 job-years in the 15-year period of analysis. This translates into a net increase of 2.2 jobs each year for 15 years. In other words, the efficiency investment made in government facilities is projected to sustain an average of just over two jobs each year over a 15-year period compared to a "business-as-usual" scenario.[52]

52. The estimate may be a conservative one when we recall that commercial buildings as a whole were shown to have a benefit-cost ratio of about 3.2 compared to the assumption of 2.0 used in this example. Moreover, the state government building efficiency program suggests a benefit-cost ratio of 3.0. See footnote 69.

TABLE 10. EMPLOYMENT IMPACTS FROM GOVERNMENT ENERGY EFFICIENCY IMPROVEMENTS			
Expenditure Category	**Amount ($ Million)**	**Job Multiplier**	**Job Impact**
Government Efficiency Improvements in Year One	$1.0	18.2	18.2
Raising Investment Revenue to Fund Efficiency Improvements	-$1.0	27.9	-27.9
Energy Bill Savings in Years One through Fifteen	$2.0	27.9	55.8
Lower Utility Revenues in Years One through Fifteen	-$2.0	6.9	-13.8
Net Fifteen-Year Change	**$0.0**		**32.3**

Note: The employment multipliers are taken from the appropriate sectors found in Table 9. The jobs impact is the result of multiplying the row expenditure change by the row multiplier. For more details, see the text.

D. Evaluating Ohio's High Energy Efficiency Scenario

The employment analysis of Ohio's alternative energy scenario was carried out in a very similar manner as the example described above. That is, the changes in energy expenditures brought about by investments in energy efficiency technologies were matched with their appropriate employment multipliers. There are several modifications to this technique, however.[53]

First, it was assumed that only 80 percent of the efficiency investments would be spent locally. Interviews with personnel from the Ohio Public Utility Commission suggest this to be a conservative value since most programs have a much higher level.

Second, an adjustment in the employment impacts was made to account for future changes in labor productivity. As outlined in the Bureau of Labor Statistics *Outlook*

53. For a more complete review of how this type of analysis is carried out, see, Howard Geller, John DeCicco and Skip Laitner, *Energy Efficiency and Job Creation*, op. cit.

1990-2005, productivity rates are expected to vary widely among sectors, ranging from a -0.2 percent productivity loss in educational services (as more teachers and staff are hired to increase the teacher-student ratio) to 3.2 percent in coal mining (where productivity gains have already led to significant job losses).[54]

To illustrate the impact of productivity gains, let us assume a typical annual labor productivity rate of one percent in manufacturing. This means, for example, that compared to 1995 a one million dollar expenditure in the year 2010 will support only 86 percent of the number of jobs as in 1995.[55]

Third, for purposes of estimating energy bill savings it was assumed that energy prices would remain at their 1990 levels. This is, in part, to simplify the matching of energy prices with an input-output model based upon 1990 price relationships. This produces a more conservative impact than might otherwise be reported since energy bill savings will be somewhat understated.

There are two important exceptions to this presumption, however: (a) that a decline in consumption would cause a downward pressure in the variable costs of supplying energy resources, and (b) that in the early years of the study the fixed costs associated with producing energy would prompt a small increase in energy prices.[56] While this might represent a "deadweight loss" in some respects, the effect will be overcome by a reduction in energy consumption that is larger than the very small energy price increase.

Fourth, it was assumed that approximately 80 percent of the investment upgrades would be financed by bank loans which carried an average 10 percent interest rate over a five-year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates — all of which might affect overall spending patterns.

While the higher cost premiums associated with the energy efficiency investments might be expected to drive up the level of borrowing (in the short-term) and, therefore, interest rates, this upward pressure would be offset to some degree by the investment avoided in

---

54. Bureau of Labor Statistics, *Outlook 1990-2005*, BLS Bulletin 2402, U.S. Department of Labor, Washington, DC, May 1992.

55. The calculation is $1/(1.01)^{15} * 100$ equals $1/1.161 * 100$, or 86 percent.

56. This is a working estimate by the American Council for an Energy-Efficient Economy for use in this analysis. Based upon a 40 percent average fixed cost, energy prices would go up by an estimated seven percent in the year 2010, for example. On the other hand, a 26 percent drop in consumption would put a similar downward pressure on energy prices that would likely offset this trend — particularly in later years as fixed costs are fully depreciated.

new power plant capacity, exploratory well drilling, and new pipelines. Similarly, while an increase in demand for labor would tend to increase the overall level of wages (and thus lessen economic activity), the modest job benefits are small compared to the current level of unemployment or underemployment. Hence the effect would be negligible.

Fifth, for the buildings and industrial sectors it was assumed that a program and marketing expenditure would be required to promote market penetration of the efficiency improvements. This was set at 15 percent of the efficiency investment for those sectors. For the transportation scenario it was assumed that, since the efficiency improvements would be an integral part of all new vehicle purchases, a "program" expenditure would not be necessary.

Finally, it should again be noted that the full effect of the efficiency investments are not accounted for since the savings beyond 2010 are not incorporated in the analysis. Nor does the analysis include other productivity benefits which are likely to stem from the efficiency investments. These can be substantial, especially those in the industrial sector.

Industrial investments that increase energy efficiency often result in achieving other economic goals like improved product quality, lower capital and operating costs, or capturing specialized product markets.[57] To the extent these "co-benefits" are realized in addition to the energy savings, the economic impacts would be amplified beyond those reported here.

57. Office of Technology Assessment, *Industrial Energy Efficiency*, Congress of the United States, Washington, DC., September 1993, page 65. For a more complete discussion on this point, see, Joseph J. Romm, *Lean and Clean Management: How to Boost Profits and Productivity by Reducing Pollution*, Kodansha American, Ltd., 1994.

V. Analytical Results

Table 11 summarizes the economic analysis of the high energy efficiency scenario for Ohio. The table provides an estimate of required investment and projected energy savings (in millions of 1990 dollars) as well as the net employment gain for selected five-year intervals through the year 2010.[58]

Table 11. Impact of Ohio Efficiency Investments

Year	Gross State Product (Million$)	Wage and Salary Compensation (Million$)	Net Jobs Gain
1995	-$270	$20	300
2000	-$80	$350	18,600
2005	$190	$800	40,100
2010	$480	$1,250	62,900

Notes: Dollar figures are in millions of 1990 dollars while employment reflects the actual job total. The implied benefit/cost ratio across the 16-year period is 1.82. The calculations are based upon a working analysis by ACEEE October 1994. They assume a 26 percent reduction in energy use over the year 2010 forecasted values.

There are a number of different aspects of Table 11 worth noting before commenting on the impacts in more detail. The first is that the impacts are largely positive. By the year 2010, Gross State Product (GSP) is projected to increase by $480 million (in 1990 dollars) despite initial losses in the years 1995 through 2000. Wage and salary compensation and employment could rise by about $1.25 billion (in 1990 dollars) and 62,900 jobs, respectively.

58. The employment benefits shown in Table 11 are not intended to be precise estimates of future economic gain for Ohio; rather they point to the pattern and magnitude of benefits associated with the kind of alternative energy efficiency scenario described in the text.

Second, while these increases are significant, the impacts are relatively small in comparison to overall activity of the Ohio economy. By the year 2010, for instance, the state's GSP might grow to almost $300 billion (in 1990 dollars).[59] Thus, adding $480 million to the Ohio GSP in the year 2010 represents an increase of only 0.2 percent. Similarly, the increases in wage and salary compensation and jobs in 2010 represent an increase of only 0.7 and 1.0 percent, respectively, by 2010.[60]

On the other hand, if the impacts are small in relation to the larger economy, it is only because the scale of investment is also relatively small. The anticipated $28 billion cumulative efficiency investment (from Table 6) is estimated to be less than 0.6 percent less than cumulative GSP in the period 1995 to 2010.

Looking at the results in more detail, we start with GSP which suffers a loss in the initial years in contrast to the small but positive gains in compensation. In 1995, the first year of the proposed efficiency investments, for example, GSP falls by $270 million while compensation rises by $20 million.

Wage and salary compensation is one category of the elements that comprise GSP, constituting about 60 percent of the GSP total. Thus, while overall GSP can fall, wage and salary compensation can rise as labor payments are substituted for investment capital in the larger economy. By 2010 both values are strongly positive although the trade-off between labor and capital continues.

In the high efficiency scenario, the employment impacts start modestly with a net employment gain of about 300 jobs in 1995. The annual total continues to climb to a net gain of 62,900 jobs in the year 2010. If we think of the job benefits as if they were provided by the relocation of a series of small manufacturing plants (to Ohio), then we can say that a 26 percent reduction in overall energy use would produce new employment that is the equivalent to the jobs supported by about 400 new manufacturing plants during

---

59. This assumes that real GSP will grow at an average annual growth rate of about 1.4 percent in the 19 years between 1991 and 2010. As referenced in Table 2, GSP in 1991 was $229 billion (in 1990 dollars). Hence, $229 billion times 1.014^{19} equals $298 billion.

60. These numbers assumes that wage and salary income and jobs will grow at an average annual rate of 1.40 and 0.6 percent, respectively. See, Bureau of Economic Analysis, *Regional Projections to 2040, Volume 1: States*, U.S. Department of Commerce, Washington, DC, June 1990, pages 44 and 45.

this period of analysis.[61] More importantly, these are jobs that tend to be more evenly distributed throughout the state.

Perhaps another way to look at this issue is to see how the alternative energy future would change the state's unemployment rate. In June 1994 Ohio's unemployment rate was estimated at 5.5 percent.[62] If that continues through the year 2010 when total employment is estimated to rise to 6.36 million jobs,[63] then Ohio's total unemployment would be 349,800. Adding another 62,900 jobs to the economy would be sufficient to lower the average unemployment rate from 5.5 percent to 4.5 percent.

Table 12 on the following page offers yet another insight into the projections. It shows how each of the major economic sectors are affected in the year 2010 in the high efficiency scenario. These are sorted according to the anticipated job impacts beginning with those sectors which suffer losses. As elsewhere it should noted that these results are not intended to be precise forecasts but rather approximate estimates of overall impact. Indeed, while the aggregate totals offer reasonable insights into the benefits of energy efficiency, some of the individual sectors show impacts that are sufficiently small that the results may swing one way or another depending upon even modest changes in the assumptions.

As might be expected, the energy industries (including wholesale trade which delivers bulk petroleum products) incur overall losses in jobs, compensation and GSP. But this result must be tempered somewhat as the industries themselves are undergoing internal restructuring.

As the electric utilities engage in more demand-side management and other alternative energy investment activities, they will undoubtedly employ more people from the business services and engineering sectors. Hence the negative employment impacts should not necessarily be seen as job losses; rather they might be more appropriately seen as occupational trade-offs. In other words, while the electric utilities may lose an estimated 8,800 traditional jobs due to selling less energy, they might gain jobs if they move aggressively into the energy efficiency business, thereby absorbing some of the job

61. This estimate is based on the year 2010 average of 62,900 jobs. It assumes a small manufacturing plant would employ 100 persons. For each job in the manufacturing plant, a total of 1.5 jobs would be supported in the economy. Therefore, each 150 jobs created by the alternative energy scenario is equivalent to the output of one small manufacturing plant. Dividing 62,900 by 150 suggests the equivalent of 419 small plants in the state.

62. Bureau of Labor Statistics, *Monthly Labor Review*, U.S. Department of Labor, Washington, DC, September 1994, page 86.

63. *Regional Projections to 2040*, op. cit.

TABLE 12. EFFICIENCY SCENARIO IMPACTS BY SECTOR IN 2010

Sector	Jobs	Compensation	GSP
Electric Utilities	(8,800)	($530)	($2,080)
Natural Gas Utilities	(2,960)	($140)	($420)
Wholesale Trade	(440)	($20)	($30)
Oil Refining	(10)	($1)	($3)
Coal Mining	20	$2	$3
Oil/Gas Mining	90	$1	$10
Pulp ad Paper Mills	220	$10	$20
Stone, Glass, Clay	310	$20	$20
Food Processing	360	$20	$36
Primary Metals	880	$60	$70
Agriculture	1,160	$10	$30
Other Manufacturing	1,640	$90	$170
Metal Durables	1,700	$90	$130
Education	1,800	$30	$30
Motor Vehicles	2,160	$160	$280
Miscellaneous	2,210	$60	$290
Government	5,120	$170	$180
Finance	5,570	$190	$240
Retail Trade	11,480	$170	$240
Construction	15,440	$420	$520
Services	24,990	$560	$740
Total	62,940	$1,350	$480

Notes: Jobs refers to the net jobs created in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net Gross State Product created in each sector. All dollar values are in millions of 1990 dollars. The column totals may not add because of rounding.

gains assigned to other sectors such as the construction and service sectors. In effect, if they begin to compete within the energy efficiency market, their job totals could increase relative to the estimates based on the conventional definition of an electric utility.

Table 12 shows four big "winners" under the high efficiency scenario. These are the collective manufacturing sectors (with a net sum of 7,260 jobs), retail trade (11,480 jobs), construction (15,440 jobs) and, finally, the service sectors (24,990 jobs). Manufacturing, retail trade and the service sectors are winners largely for two reasons. First, they benefit from the new investments in energy efficiency programs and technologies. Second, they benefit from the higher level of goods and services sold in Ohio as people and businesses respend their energy bill savings elsewhere in the economy.

The construction sector is a winner primarily as the industry that most directly benefits as special trade contractors and others are hired to install the new technologies and make the requisite efficiency upgrades. The construction sector alone pulls in about 25 percent of the net job increases in the year 2010. Using the construction industry as a benchmark for evaluation, it might be noted that about 25 percent of the job impacts in 2010 are from the efficiency investments made in that year. The balance of the impacts (or 75 percent) are the result of the respending of the energy bill savings.

VI. Ohio Energy Policy: Review and Recommendations

A. Current Policy Review

Support for maintaining and developing the state's traditional indigenous resources (i.e., coal, oil and natural gas) and load building by many of the state's utilities have overshadowed efforts to increase energy efficiency and reduce energy consumption over the past 20 years.

In an effort to help the coal industry, for instance, the state of Ohio has initiated an aggressive and costly effort — in spite of the relatively small number of jobs it supplies. Fueled by a 1985 ballot issue amending the state constitution, up to $100 million (at any one time) in state bond financing was authorized to support the Ohio Coal Development Office's coal research and development activities. These monies, in the form of grants, loans, or loan guarantees, are currently being used to maintain or encourage greater use of the state's coal resources. Recent efforts include: developing clean coal technologies (e.g., support for more than 40 pilot and demonstration projects in near-to-term technologies), and initiatives to utilize and export these technologies.[64]

Although much of the state's energy priorities historically have been focused on coal and coal development, other more sustainable energy and employment opportunities are ripe for development as part of Ohio's economy. Residents and industry are starting to connect energy efficiency with quality of life issues and a way to save money, rather than simply accept energy as a fixed cost to be paid regardless of its use.

Building upon the 1977 legislative mandate of the Ohio Department of Energy (formerly the Ohio Energy and Resource Development Agency) to pursue more efficient use of existing, new and alternative energy resources to enhance economic development of the state, some modest initiatives have emerged.[65]

Like its predecessor, the Ohio Department of Energy was also short lived. Downgraded to a Division of the Department of Development in 1983, and then completely abolished in 1985 by the Legislature, many of its previous functions were transferred to various other agencies. These include: the Department of Development, the Department of Administrative Services, and the Public Utilities Commission of Ohio (PUCO). In spite of the tenuous nature (at least in name) of the state's energy offices, some progress has been made and initiatives are being pursued to support energy efficiency and greater savings in the public and private sectors.

The Division of Energy Services, recently created within the Department of Administrative Services, is spearheading state efforts to curb energy expenditures in government owned buildings and vehicles. State government energy expenditures exceeded $65 million dollars in fiscal year 1994.[66]

---

64. This refers to technologies which are now available for commercial application and others which show great promise and may be available shortly after the turn of the century. For more information on these efforts see *Ohio Coal Development Agenda*, op. cit.

65. Responding to repercussions from the Arab oil embargo and the obvious links between economic development and the state's energy resources, production and consumption, in 1977 the Ohio Legislature adopted House Bill 415 which abolished the Energy Resource and Development Agency and gave new direction for the Department of Energy. For more details see the bill itself, or for a brief discussion see *The Ohio Energy Strategy Foundation Report*, op. cit., page 16.

66. This information is based on personal communications with Jeff Westhoven, Deputy Director of the Ohio Department of Administrative Services, Division of Energy Services and the State Government Energy Coordinator, in October 1994. Mr. Westhoven noted that these expenditures included electric ($32 million), natural gas ($18 million), motor gasoline ($6 million), water ($7.5 million), and coal/propane/diesel fuels/other ($2.5 million) expenditures for the state's 30 million square feet of total building space (including offices, hospitals, schools, libraries, etc.) as well as fuels for the its fleet of 12,100 vehicles.

As part of this broad effort to reduce energy expenditures the state of Ohio will be adopting energy efficient procurement practices in July 1995. It has recently become a State Green Lights Partner,[67] and it has the only state government building chosen to be a participant in the EPA Energy Star Building Program.[68]

Complementing these efforts, the Division of Energy Services, in cooperation with many of the state's utilities is currently conducting energy audits on state buildings at the rate of one million square feet per month. To fund those improvements deemed cost-effective the Division is proposing a $20 million budget to be presented in the next state budget cycle beginning in fiscal year 1996. As suggested by the example shown in Table 10 of this study, increasing energy efficiency within state buildings may be one of the important job creation initiatives established in Ohio.

If approved, these monies (an initial state capital outlay of $13 million) will be used to set up an Energy Bank. Money from the bank will provide funding for cost-effective energy efficiency improvement projects over the next four years. The projected savings from reduced energy expenditures — between $4 million and $5 million annually — will be returned to the Energy Bank to fund additional energy efficiency projects.[69]

The Office of Energy Efficiency (OEE), within the Department of Development, has also successfully sponsored programs in energy education awareness, residential weatherization, and institutional conservation among others. They have developed updated state building codes and are currently pursing initiatives to link energy efficiency strategies with economic competitiveness and environmental benefits.

In mid-1994, the State of Ohio adopted the 1993 version of the Council of American Building Officials' (CABO) Model Energy Code for residential buildings to replace the

67. The Green Lights Program is administered by the U.S. Environmental Protection Agency (EPA). The program focuses on reducing energy use and pollution prevention by promoting the benefits of energy efficient lighting. State Green Lights Partners pledge to upgrade to energy efficient lighting where cost-effective in all state-owned buildings within the next five years. For more information, contact the U.S. EPA Green Lights Program in Washington, DC.

68. The Energy Star Building Program is a pilot program being conducted, also by the Environmental Protection Agency (EPA). The program involves 24 buildings chosen through a nationwide competition to receive engineering assistance to perform an energy audit and make recommendations to showcase the benefits of installing cost-effective energy efficiency measures (to be paid for by the state). Based on the analysis performed on the Lausche Building in Cleveland, lighting, heating, ventilating and air conditioning (HVAC) and other improvements will be made by the state. Lighting improvements alone are already estimated to save $90,000 annually.

69. According to Mr. Westhoven the energy efficiency improvements will provide a good financial return on investment for the state yielding a present value ratio of savings to investment of 3:1. He also noted that similar programs are currently in place in Iowa, California, Texas and New York.

1987 CABO Model Energy Code they have been following. However, due to the anticipated difficulty of assuring local code officials understand the new code, as well as the need for a compliance verification tool, the new residential building code effective date is being delayed and does not take effect until July 1, 1995.

In August 1994 Ohio adopted a codified version of ASHRAE 90.1 (ASHRAE 1990 A and B are the existing commercial standard) with the addition of BOCA 1993 National Building Code requirements for their commercial building code. This brings Ohio into compliance with the federal Energy Policy Act of 1992, and should lead to significant efficiency improvements in new buildings.[70]

If successful, the OEE pilot program will also involve utility investments to perform integrated resource efficiency assessments at commercial and industrial sites throughout their service territories. The assessments are intended to address process improvements, overall system performance, waste minimization, plant layout and a host of other potential improvements.

These energy efficiency opportunities would not only help reduce utility loads, but help the involved businesses improve their overall operations, hold down energy costs (i.e., reduce energy consumption through demand-side management), and help to ensure their economic viability. The program is currently being supported by Cincinnati Gas and Electric (CG&E), an investor owned utility (IOU), and at least ten of the state's municipal utilities are interested.[71]

In recent years the PUCO and individual utilities have taken some steps toward promoting energy efficiency programs, known in the energy field as demand-side management (DSM) programs. These are programs undertaken by a utility to help their customers reduce their demand for electricity consumption. Among other things, the commission has required the state's IOUs to prepare integrated resource plans every two years. As part of this mandate utilities are allowed to recover DSM-related program

---

70. ASHRAE stands for the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. BOCA refers to the Building Officials and Code Administrators International. All references to the Ohio building codes are based upon a personal communication with Terry Smith, Field Representative with the Office of Energy Efficiency, Ohio Department of Development, September 1994.

71. This information is based on personal communications with Bob Garrick at the Ohio Office of Energy Efficiency in August 1994. Mr. Garrick noted that he is encouraged by the response from these municipal utilities since most have shown little interest in DSM and are currently pursuing efforts to expand their load.

costs and lost revenues as well as earn an incentive bonus equal to 10 percent of the net DSM induced benefits, all of which must be recovered during a rate case.[72]

More recently, the Commission has become more skeptical of DSM performance in Ohio. Consistent with this view, it is giving little guidance or assurance on cost recovery. The Commissions's position is closely linked to the weak effort and lack of results from utility DSM programs implemented so far.[73]

In 1993 the state's IOUs spent a combined total of $37.5 million on DSM programs which primarily target the residential sector. This represents less than 0.4 percent of the total electric utility revenues for 1993. The programs included: energy awareness and education, energy efficient lighting replacements, energy efficient motor replacements, energy audits, weatherization, water energy efficient heating and cooling replacements, old appliance pick-ups and more.[74]

One Ohio utility with an active DSM program is Dayton Power & Light (DP&L). In a 1991 rate case DP&L agreed to spend $60 million on DSM over a four-year period. As part of the settlement, a DSM collaborative was established involving DP&L and a variety of non-utility partners (including the Sierra Club).[75] Review and refinement of the utility's DSM programs by the collaborative resulted in more than $23 million in spending on DSM programs in 1993.[76]

---

72. This information is also based on personal communications with Mr. Garrick in August 1994 as well as information contained in a recent report by Martin Schweitzer et al., *Making a Difference: Ten Case Studies of DSM/IRP Interactive Efforts and Related Advocacy Group Activities*, Oak Ridge National Laboratory, Oak Ridge, TN., March 1994, page 27.

73. This information is based on personal communications with David Festa, Deputy Director of the Center for Clean Air Policy in Washington, DC., in August 1994 and appears to be further substantiated by a recent article "Ohio Rejects use of Fuel Component as Means of Recovering DSM Costs," in *DEMAND-SIDE REPORT*, McGraw-hill, August 18, 1994, pages 1-2.

74. This information on program expenditures and types is based on personal and written communications with Steve Puican at the Public Utilities Commission of Ohio, Utilities Department, Forecasting Division, in August 1994.

75. See Martin Schweitzer et al., *Making a Difference: Ten Case Studies of DSM/IRP Interactive Efforts and Related Advocacy Group Activities*, op. cit., page 25.

76. Similar to DP&L, Cincinnati Gas and Electric (CG&E) has also formed a collaborative, but it does not have a signed DSM settlement agreement. Nevertheless, according to personal communications with Ned Ford of the Sierra Club, in August 1994, CG&E has one of the most aggressive DSM programs of the Ohio utilities. According to Mr. Puican (referenced above, CG&E spent a total of just over $3.8 million on DSM programs in 1993. DSM expenditures for DP&L are also based on information provided by Mr. Puican.

Although a significant amount, this DSM expenditure — approximately two percent of DP&L's revenues for that year — is modest in comparison to the expenditures by those utilities around the country that are aggressively pursuing cost-effective DSM strategies and spending between 3.6 and 6.8 percent of their revenues.[77] Moreover, the remainder of the state's IOUs spent even less than DP&L on DSM programs, ranging from 0.06 to 0.36 percent of their 1993 revenues.[78]

In an effort to boost its DSM commitment, American Electric Power (AEP), the parent company of Columbus Southern Power, Ohio Power and other utilities outside Ohio, recently announced plans to initiate a new load-shifting program to lower customers bills and help AEP avoid some future additions to their generating capacity.

The program involves installing residential energy management systems (i.e., special thermostats) to offer variable energy pricing to 25,000 residential customers by the end of 1997. The new thermostats will enable users to shift electricity usage to off-peak periods to take advantage of lower rates.[79] Ohio Power is currently involved in an electric rate case (in part to recover $11.9 million in DSM cost recovery), and is anticipating having 20 DSM programs (almost double its current total) in place by the end of March 1995.[80]

Complementing these very modest utility efforts, the state's newly released energy policy *The Ohio Energy Strategy Foundation Report*, a product of the PUCO's Ohio Energy Strategy Interagency Task Force, provides guidelines (i.e., seven broad strategies and 53 initiatives) to develop and utilize energy resources in the state. The report seeks to coordinate long-term energy security with economic and environmental sustainability and addresses many of the key issues: education, energy efficiency, indigenous resources,

---

77. This includes both public and investor owned utilities such as Wisconsin Public Service which spent 6.8 percent of revenues on DSM in 1992, Sacramento Municipal Utility District in California at 6.2 percent, Seattle City Light in Washington at 6.1 percent, Boston Edison in Massachusetts at 4.0 percent, and Florida Power at 4.3 percent among numerous others. For more details and a comprehensive listing see a recent report by Eric Hirst, *Costs and Effects of Electric Utility DSM Programs: 1989 through 1997*, Oak Ridge National Laboratory, Oak Ridge, TN., June 1994.

78. According to information provided by Mr. Puican, Cincinnati Gas & Electric spent 0.36 percent, Cleveland Electric Illuminating spent 0.21 percent, Columbus Southern Power spent 0.23 percent, Monongahela Power spent 0.06 percent, Ohio Edison spent 0.06 percent, Ohio Power spent 0.08 percent and Toledo Edison spent 0.22 percent in 1993.

79. See "AEP Plans to Install 25,000 Residential Energy Management Systems by 1997," *DEMAND-SIDE REPORT*, McGraw-Hill, March 31, 1994, pages 1-2.

80. See "Ohio Power Seeks $11.9-Million in DSM Cost Recovery; 8% of Rate Hike Request," *DEMAND-SIDE REPORT*, McGraw-Hill, July 21, 1994, pages 6-7.

renewable resources, electric supply and demand, government policies and programs and state government energy consumption.[81]

B. Policy Recommendations for Ohio

The high efficiency scenario offers a significant economic benefit for the citizens and businesses of Ohio. However, a serious commitment to secure that economic return will require important policy changes, implementation of cost-effective energy programs, and clear direction from the PUCO to the state's utilities.

More specifically, state policy initiatives will need to encourage the investment of $28 billion in energy efficiency technologies over the period 1995 through 2010. Current policy initiatives will fall considerably short of achieving that goal. Below we recommend a broad set of policy initiatives that the state could adopt to ensure that level of investment and to move towards the high efficiency scenario.

1. Building Codes

Ohio has recently upgraded its state building codes in accordance with requirements and recommendations in the federal Energy Policy Act of 1992. New commercial buildings must meet or exceed the ASHRAE 90.1 model standard and new residential buildings must meet or exceed the current CABO model code. On paper, Ohio has reasonable building codes.

Implementing these energy codes could have significant impacts in a state like Ohio. A recent analysis for Illinois shows that adopting the model building codes referred to above could cut energy use in affected buildings by 10-18% and lower consumers' energy bills by more than $600 million over a ten-year period.[82] Also, these building codes are very cost effective for consumers, based on energy prices similar to those in Ohio.

But code adoption at the state level is just one step towards increasing the energy efficiency of new buildings. Building codes are implemented and enforced at the local level in Ohio. Energy code compliance is critical for achieving the potential benefits,

---

81. For more details on the individual strategies or initiatives see *The Ohio Energy Strategy Foundation Report*, op. cit.

82. *Energy Efficiency Codes and Standards for Illinois*, op. cit.

and compliance levels are surprisingly low in many states.[83] Designers and builders need to be trained on how to comply with new building codes. Local code officials need training as well as adequate financial and technical resources for enforcing the codes. In order to make the new codes a success, state agencies and possibly utilities should sponsor education, training and compliance programs.

2. Integrated Resource Planning and Demand-Side Management

The PUCO and individual utilities in Ohio have made some useful initial steps in the areas of IRP and DSM. But much more needs to be done if Ohio is to realize the large energy and economic benefits offered by effective IRP and DSM. Regarding IRP, while initial plans have been prepared by the states' utilities, these plans in general include poorly designed and/or relatively few DSM programs, inappropriate DSM screening procedures, and relatively low avoided costs.[84] The plans need to be revised and improved, particularly with respect to energy efficiency opportunities.

Likewise, DSM programs offered so far by Ohio's utilities are very modest in scale and rather immature in design. These programs appear to have had little impact on energy demand, and are not being viewed as an economical alternative to expanding generating capacity.

Utilities, continuing to work with the "collaboratives" that have been formed throughout the state, should commit to adopting greatly expanded and improved DSM programs if they appear to be cost effective from the societal perspective. Utility DSM programs should be adopted for natural gas as well as electricity, where cost-effective based on full long run marginal costs.

The DSM programs should include substantial incentive payments and other features necessary to overcome the barriers inhibiting widespread adoption of energy efficiency measures by consumers in all sectors. And comprehensive approaches should be adopted to facilitate market transformation in key end uses.[85] Expanded utility DSM efforts should be initiated in Ohio no matter what happens in the way of utility restructuring or competition, based on the economic benefit and service to consumers that such programs can provide.

---

83. Ibid.

84. Personal communication with David Festa, Center for Clean Air Policy, Washington, DC, Nov. 1994.

85. H. Geller and S. Nadel, "Market Transformation Strategies To Promote End-Use Efficiency," in *Annual Review of Energy and Environment*, Annual Reviews, Inc., Palo Alto, CA, 1994.

Moreover, DSM investments should be viewed as a strategic option for avoiding or deferring capital investment in electricity supply systems, including avoiding repowering of older power plants and installation of environmental compliance technologies (i.e., efficiency can reduce the need for other pollution control systems).

Some utilities in the Midwest have adopted this perspective and have already reduced electricity use by 2-3 percent and peak demand by 6-9 percent through their DSM programs.[86] Once new DSM program design and analysis is performed by Ohio's utilities, electricity savings and peak demand reduction targets should be set. And these targets should be revised periodically based on real world results. Obviously, the PUCO can play a key role in encouraging this new commitment to DSM in Ohio.

Regulatory reforms have been adopted in Ohio so that utilities could have financial incentives for implementing substantial and effective DSM programs. But these rate recovery and incentive provisions do not appear to have been used so far.[87] Of course this relates to the limited amount of DSM activity in the state. The PUC should reaffirm its support for these principles and make them operative, in conjunction with greater DSM commitments on the part of utilities. For example, PUCO should allow rapid cost recovery for cost-effective DSM programs in between major rate cases. Last but not least, thorough evaluation of the costs and benefits of DSM programs is needed in order to support the use of financial incentives.

3. Industrial Energy Efficiency

Although industrial energy prices are relatively low in Ohio, significant potential still exists for improved energy efficiency in the industrial sector. On the supply-side, the state could modify the coal development program to include a renewable energy resource development strategy. On the demand-side, an integrated strategy will be required to achieve good success, combining several types of state and utility programs that facilitate all aspects of the implementation process from opportunity identification, to design and installation, to training and operation. These initiatives will need to include programs targeted at reducing the cost of identifying efficiency improvements (e.g., survey, technical and purchasing assistance)and installing the efficiency measures (e.g., rebates

---

86. The best utilities in the Midwest with respect to DSM programs include Wisconsin Electric Power, Wisconsin Public Service, and Northern States Power. These utilities were spending 2-7 percent of their revenues on DSM programs as of 1992. See, *Costs and Effects of Electric Utility DSM Programs*, op. cit.

87. Personal communication with David Festa, op. cit. There has been some recovery of DSM expenses through settlement agreements, however.

and loan programs). An example of this approach is the New York State Energy Office industrial program which addresses each step in the implementation process.[88]

Opportunity Identification

Identification of energy efficiency opportunities is the first step in the process. Utilities have close contact with industrial energy users and are a good position for delivering information. Utilities as part of their DSM programs can offer training for customers on efficiency technologies, audit services and assistance in identifying the experts required to take advantage of the may efficiency opportunities. A number of utilities around the country have implemented highly successful industrial DSM programs, and Ohio's utilities should look to these efforts as models.[89]

The Energy Analysis and Diagnostic Center at University of Dayton is an existing resource that could be augmented with funds and expertise from both the state government and the electric utilities.[90] This successful program, which receives its core funding from the U.S. Department of Energy, provides low-cost audits to small and medium-sized firms. It can serve as a scout for opportunities that can be pursued by other key players such as gas and electric utilities. In addition, the program trains engineers in industrial energy-efficiency techniques, and these individuals should be encouraged to seek employment in Ohio's industrial sector.

Design and Installation

Industrial access and knowledge of where to procure to specialized expertise and energy services can be barriers to implementing efficiency opportunities.[91] The Mid-West Manufacturing Technology Center in Ann Arbor, Michigan (funded by the U.S.

---

88. R. Neal Elliott and Aliza Weidenbaum, "Financing of Industrial energy efficiency through State Energy Offices", proceedings of *The 1994 Industrial Energy Technology Conference*, April, 1994, Houston, TX.

89. Steven M. Nadel and Jennifer A. Jordan, *Designing Industrial DSM Programs that Work*, American Council for an Energy-Efficient Economy, Washington, DC, December 1993.

90. U.S. Department of Energy, *Energy Analysis and Diagnostic Center Program Description*, Washington, DC, 1994.

91. Howard S. Geller and R. Neal Elliott, *Industrial Energy Efficiency: Trends, Savings Potential, and Policy Options*, American Council for an Energy-Efficient Economy, Washington, DC, 1994; and U.S. Department of Energy, *Efficient Electric Motor Systems for Industry*, Washington, DC, 1993.

Department of Commerce) provides one example of the kind of resource that might be developed in Ohio.

Financing

An Energy Bank program should be created for industrial and commercial users, particularly for small to medium-sized companies which tend to be more capital constrained than larger firms. The New York State energy loan program has been particularly successful in funding process improvements which offer the greatest potential for structural changes in energy efficiency.[92] Even greater impact might be realized if utilities and the state were to cooperate with the financial community to make attractive financing available. Based on the New York experience, we suggest a total loan pool of $50 million with attractive interest rates of 2.5 to 3.0 percent per year as seen in the New York State program.

Operation

Once efficiency measures are installed, individual plant staff must learn how to operate process systems to achieve their full energy savings potential. The New York program is unique in that it provides customized training as part of their energy services program.[93] The development and funding of an energy technology curriculum within the Ohio community college system, along with on-the-job training services provided by the state and utilities will help insure that the energy savings potential of improvements are realized in operation.

By coordinating efforts and providing comprehensive assistance to industry on energy efficiency, Ohio can plot a more productive and secure future for its industrial sector. Many energy efficiency improvements offer other multiple benefits such as reduced production cost, increased productivity and product quality, and reduced environmental emissions. These can be a greater motivation than energy cost savings. Such benefits to the industries often exceed the value of the energy savings and improve their profitability and competitiveness.[94] Thus, an industrial energy efficiency strategy in Ohio should emphasize the broad benefits that result from industrial process improvements and modernization.

---

92. "Financing of Industrial Energy Efficiency through State Energy Offices," op. cit.

93. Ibid.

94. *Industrial Energy Efficiency: Trends, Savings Potential, and Policy Options*, op. cit. See also, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, op. cit.

4. Light Vehicle Efficiency

Three types of policy options are available to states for improving the energy efficiency of cars and light trucks. We recommend that Ohio pursue these options through legislation and resolutions to implement them in forms that are appropriate to Ohio, given state fiscal policies and economic interests. First, Ohio should enact vehicle purchase price incentives ("feebates") linked to efficiency. Second, Ohio should procure vehicles that are the most efficient in each vehicle class and coordinate efforts for similar efficient vehicle procurement efforts by municipalities and private fleet purchasers in the state. Finally, Ohio should provide concerted political support for stronger Federal policies to advance vehicle efficiency.

Ohio is second only to Michigan in terms of the number of vehicle production facilities. The state is also home to many important auto parts supplier firms. Historically, most lasting improvements in vehicle efficiency have come from improved technology rather than market shifts among type of vehicles. This will also be the case for future efficiency improvements, especially if they are policy-driven. Thus, Ohio's vehicle manufacturers will benefit from selling more energy-efficient, higher value vehicles. State leadership in this area will pay a double dividend: first, increased economic activity through investments in efficient Ohio vehicle production; and second, the widespread consumer benefits resulting from the savings on gasoline expenditures as more efficient vehicles come into use.

Under current market conditions and those likely to prevail in the absence of a major oil supply disruption, there is low consumer and manufacturer interest in higher fuel economy. Ohio can create revenue-neutral incentive for higher efficiency by establishing feebates: lower taxes or rebates on vehicles that are more efficient than average. These rebates would be financed by higher taxes or fees on less efficient vehicles. In Ohio, the current sales tax rate on vehicle purchases is 5 percent.[95] This could be converted to a sliding-scale feebate system with a tax ranging from 0 to 10 percent of a vehicle's sales price.[96]

---

95. Local jurisdictions may add another one to two percent to this base rate. Personal communication with the Ohio Department of Taxation, Columbus, OH.

96. Further discussion of how to design such a proposal and a review of other states' efforts to develop efficiency-linked vehicle incentives is provided by J.M. DeCicco, H.S. Geller, and J.H. Morrill, *Feebates for Fuel Economy: Market Incentives for Encouraging Production and Sales of Efficient Vehicles*, American Council for an Energy-Efficient Economy, Washington, DC, May 1993. See also, W.B. Davis, and D. Gordon, *Using Feebates to Improve the Average Fuel Efficiency of the U.S. Vehicle Fleet*, Report LBL-31910, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, January 1992. The state's authority to enact feebates is presently clouded by a preemption dispute between the U.S. Department of Transportation and the State of Maryland. In 1992, Maryland enacted a modest feebate, converting the state's existing flat 5 percent titling tax into a sliding-scale tax depending on fuel economy

Ohio can also lead the way to more efficient vehicles by establishing procurement policies for state fleets to buy the most efficient vehicles in a given class. The state can multiply the effects of its own procurement by playing a coordinating role for similar procurement efforts by county and municipal fleets along with voluntary efforts by private fleets.

A similar strategy is now being pursued for alternative fuel vehicles. However, the scope of such efforts is limited by alternative fuel infrastructure needs. An effort to purchase efficient vehicles would have a much broader scope and is likely to deliver greater fuel conservation and emissions reduction benefits in a more timely fashion. An efficient vehicle procurement strategy can be designed with two stages. One stage would be directed toward bulk purchases of current production vehicles that are "best-in-class" in terms of fuel efficiency.

The second stage could be directed to advanced, next-generation vehicles having substantially higher efficiencies, should they become available. This element could be tied to a nationwide effort to provide a "Golden Carrot" for ultra-efficient vehicles. This proposal, termed the "Green Machine Challenge," is being explored as a way to accelerated the commercialization of promising advanced technologies for vehicle efficiency.[97]

Finally, it is important to note that cars and light trucks are produced for a national, if not international market, in which any one state holds only a small share. All states will benefit from an overall improvement in car and light truck efficiency and while the leverage of any one's states market is limited, all bear a responsibility to help set the nationwide direction of the market.

For this reason, federal policy plays a determining role in the types of vehicles consumers can buy and this role is particularly crucial in areas of public concern, such as safety, emissions, and efficiency. Since Ohio stands to greatly benefit from a nationwide effort for higher vehicle efficiency, the state should, therefore, play an active role in pressing for the full range of Federal policies to induce greater vehicle efficiency, including stronger fuel economy standards, feebates linked to higher efficiency (in which

---

but capped at a one percent differential. Implementation was challenged by the Bush Administration's Department of Transportation but the Maryland Attorney General has defended the proposal, noting that only technical changes would be needed to avoid violating preemption clauses. Resolution of this dispute is still pending.

97. *The Green Machine Challenge*, a policy proposal, American Council for an Energy-Efficient Economy, Washington, DC, March 1993.

state feebates can complement a more widespread federal program), and a nationwide Green Machine Challenge.

5. Price Signals

Conventional energy sources are heavily subsidized, resulting in relatively low energy prices in Ohio and throughout the United States.[98] At the same time, Ohio relies on income and sales taxes for a major source of its needed revenues. By shifting a portion of this tax burden away from income and sales taxes to energy consumption, the resulting energy price change would make efficiency even more attractive. The lower income and sale tax rates would also have a positive effect on the Ohio economy while allowing the state to continue providing needed government services. Moreover, if the price increase was the result of a carbon-based energy tax, the price changes would be a clear signal that encouraged the use of low-carbon, renewable energy sources such as biomass fuels as well as solar and wind resources.

There are a number of ways to offset consumer and business taxes so that when, combined with higher energy taxes, the net result is revenue neutral.[99] There could be direct reductions in income taxes across the board. Generally, however, a greater efficiency benefit will be obtained if a portion of the energy tax offset is linked to investments which directly improve energy efficiency. Instead of a general income tax reduction, a tax credit could be provided for investments in energy-efficiency improvement up to the individual's or company's state tax liability.

Because studies have shown that for the industrial sector investments in process modernization lead to greater overall energy efficiency,[100] ACEEE recommends that any investment for process improvement be allowed under a tax credit, if the tax credit approach is followed. Any surplus revenues resulting from the energy tax would then be used to fund programs such as the Energy Bank, or to make technical services available to energy consumers.

---

98. This point was discussed in the introduction of this study. See, *Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts*, op. cit.

99. F. Muller and J.A. Horner, "The promise of state carbon taxes: opportunities and policy issues," *State Tax Notes*, March 8, 1993; R.C. Dower and M.B. Zimmerman, "The Right Climate for Carbon Taxes: Creating Economic Incentives to Protect the Atmosphere," World Resources Institute, Washington, DC, August 1992.

100. Marc H Ross and Daniel Steinmeyer, "Energy for Industry", *Scientific American*, September, pages 89-98, 1990.

6. Forming a Sustainable Energy Development Agency

Our final policy recommendation is to convert the Ohio Coal Development Office to a Sustainable Energy Development Agency. There are a number of reasons for doing this. First, as noted earlier in this report, coal is a very small and a declining industry in Ohio. In fact, statewide employment in the coal industry fell to under 5,000 as of 1992. Moreover, the outlook for Ohio's coal industry is bleak given increasing automation and shifts towards low-sulfur western coal, the adoption of national acid rain reduction requirements through the 1990 Clean Air Act Amendments, and increasing concern about global warming and commitments by the United States and other nations to reduce carbon dioxide and other greenhouse gas emissions.

Unlike the coal industry, energy efficiency improvements and renewable energy technologies are growth industries with an extremely promising future. Given its traditional strength in manufacturing fabricated goods such as motors, appliances, lighting products, and insulation materials, Ohio has the potential to become a leading manufacturer of energy efficiency technologies. Ohio also has substantial wind and biomass energy resources, and could develop manufacturing and production capacity related to these energy sources as well.[101]

Some states including California, Florida, Iowa, New York, and North Carolina fund and operate state energy R,D&D agencies that emphasize energy efficiency and renewable energy technologies. These agencies support technology research and development, demonstrations, field monitoring, and in some cases education, training and other implementation activities. A number of the state energy R,D&D agencies are funded through small utility surcharges or utility contributions.[102]

A Sustainable Energy Development Agency in Ohio could provide a number of functions working with manufacturers and consumers in Ohio, including: 1) applied R&D and demonstrations of advanced energy efficiency and renewable energy technologies; 2) technology and market assessments; and 3) support for technology transfer and commercialization. The agency could also help Ohio's utilities and state agencies in the design and evaluation of energy efficiency and renewable energy programs, and possibly assist with training or technical assistance concerning building code implementation or improving industrial energy efficiency. In summary, a Sustainable Energy Development

---

101. See *Powering the Midwest: Renewable Electricity for the Economy and the Environment*, Union of Concerned Scientists, Cambridge, MA, 1993.

102. For more information on these state energy R,D&D agencies, see Jeffrey P. Harris, et al., "Energy-Efficiency Research, Development and Demonstration: New Roles for U.S. States," *Energy Policy*, December, 1993, pp. 1205-1216.

Agency could be of great value in helping Ohio achieve the economic and environmental benefits outlined in this report.

VII. Conclusion

Based on the analysis of an alternative high energy efficiency scenario, it seems clear that a policy of accelerated energy efficiency improvements can help ensure that Ohio citizens have an adequate supply of energy at the lowest reasonable cost to the consumer. Total statewide expenditures for energy in 2010 are about 12 to 15 percent lower in the high efficiency scenario relative to the baseline projections.

But the alternative energy investments are also likely to provide significant macroeconomic and environmental benefits as well. For example, we estimate that there would be a net increase of 63,000 jobs in Ohio by 2010 as a result of pursuing the high efficiency scenario. Those jobs are equivalent to the employment supported directly and indirectly by about 400 small manufacturing plants. On the environmental side, we estimate that the energy savings projected in this analysis suggests that carbon emissions would be reduced by about 22.5 million metric tons by the year 2010.[103]

Hence, energy efficiency investments are more than mere cost-cutting measures. They yield both positive environmental benefits and net employment gains. Given the higher employment and income opportunities, energy efficiency investments properly belong in the category of critical economic development strategies for Ohio.[104] The analysis reported here is both consistent with and confirmation of the mandates set forth in the *Ohio Energy Strategy* discussed earlier in the study.

One important aspect of the energy efficiency scenario is that "it takes money to make money." In order to achieve the level of economic benefits illustrated in Table 11, policies must be adopted and effectively implemented to encourage a $28 billion investment in the period 1995 through 2010. Averaged out over the 16-year period, this

---

103. The high efficiency scenario will also result in fewer emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), and will help the utilities meet their Clean Air Act requirements. As an example, in an analysis for a large Indiana electric utility, ACEEE found that an optimum DSM scenario can reduce SO_2 emissions by 18.6 percent of the total required due to the 1990 Clean Air Act Amendments. See, Steven Nadel, et al., *Using DSM to Help Meet Clean Air Act Targets: A Case Study of PSI Energy*, American Council for an Energy-Efficient Economy, Washington, DC, November 1994.

104. A recent report evaluating the Clinton Administration's *Climate Change Action Plan* reached a similar conclusion noting that it could lead to as many as 260,000 more jobs for the United States in the year 2010. See, Skip Laitner, *The Climate Change Action Plan as an Economic Development Strategy for the United States*, American Council for an Energy-Efficient Economy, Washington, DC, May 1994.

implies an average annual investment of $1.75 billion — about eight percent of Ohio's current energy bill.

While the investment is modest in comparison with the anticipated energy expenditures, because the efficiency investments will take an average of 3-5 years to pay for themselves, the state and its private investors will be laying out greater sums of money than is being saved in the early years of the program. In fact, the cross-over point where annual savings exceed annual investment will not occur until about the year 2000, assuming that large-scale investments begin in 1995.

Overcoming the initial hurdle of redirecting financial investments away from conventional energy resources and towards energy efficiency technologies will not occur without concerted action by policy makers in Ohio, along with critical support from the Federal government. But that may also be the good news for Ohio as well as the American economy. The efficiency improvements can help avoid the need to build costly and risky new conventional energy facilities. Much of the funding, therefore, may simply be the result of diverting investments away from traditional energy supply resources and into energy efficiency technologies.

If Ohioans wish to capture the full economic benefits of the high efficiency scenario, we suggest that a number of policies be adopted, including:

*** Training and support for the effective implementation of the state's newly adopt residential and commercial buildingg codes;

*** Improved integrated resource planning and expanded demand-side management programs for both the natural gas and the electric utilities;

*** Expanded financial and technical support to accelerate both energy and process efficiency improvements in the industrial sector;

*** Adoption of policies which improve the energy efficiency of cars and light trucks;

*** Improved energy price signals including a revenue-neutral energy or carbon tax to encourage investments in energy efficiency in all sectors; and

*** Conversion of the Ohio Coal Development Office into a Sustainable Energy Development Agency that would fund R,D&D and possibly other activities in support of energy efficiency and renewable energy implementation.

These initiatives, along with other actions that can be taken to increase energy efficiency and economic productivity, can help to ensure a healthy economy and a clean environment in Ohio in the coming decades.